DRAFT FINAL

SAMPLING AND ANALYTICAL PLAN
COOLING POND AND BERM CHARACTERIZATION
THE STIMSON LUMBER COMPANY

Missoula County, Montana

Prepared For:

Montana Department of Environmental Quality
P.O. Box 200901
Helena, Montana 59620-0901

DEQ Contract No. 401026-TO17

October 18, 2006

Olympus Work Order No. A1534

Olympus Technical Services, Inc.

765 Colleen St.
Helena, MT 59601
Phone (406) 443-3087

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1.0 INTRODUCTION

Olympus Technical Services, Inc. (Olympus) has prepared this Sampling and Analytical Plan (SAP) for the Montana Department of Environmental Quality (DEQ) under DEQ Contract No. 401026-TO17. The SAP presents the sampling approach for additional characterization of sediment and fill material in the Stimson Lumber Company (Stimson) Cooling Pond and Berm (Site) and contains the Standard Operating Procedures (SOPs) for conducting the field sampling activities. An initial assessment of cooling pond sediment quality was conducted by Olympus on behalf of the DEQ in the Spring of 2006 (Olympus, 2006). The study identified the presence of polychlorinated biphenyls (PCBs) and extractable petroleum hydrocarbon (EPH) compounds in the pond sediment. The SAP incorporates several components, including: 1) a project description that describes the site setting and data quality objectives; 2) the Field Sampling Plan (FSP) that describes sampling procedures; 3) the Quality Assurance Project Plan (QAPP) that describes quality assurance procedures for the field and laboratory data for the project; and, 4) the Laboratory Analytical Plan (LAP).

2.0 PROJECT DESCRIPTION

The Site is located in Bonner, Missoula County, Montana, within Section 22, Township 13 North, Range 18 West, Montana Principal Meridian at Latitude 4° 52’ 34” North, Longitude 113° 51’ 57” West, as shown on Figure 1. The Stimson Bonner Mill is a sawmill and plywood manufacturing facility. The cooling pond collects water from various sources at the Stimson Bonner Mill including, boiler blow down water, yard runoff, and Non Contact Cooling Water (NCCW). The pond has dimensions of approximately 470 feet by 75 feet and covers an area of approximately 33,000 square feet. The water depth is variable, ranging from less than 1 foot in the western portion of the pond to at least 9 feet in the eastern portion of the pond at the time of the pond sediment characterization field work (March 2006). Water generally enters from several inlet pipes along the south side of the pond and is discharged to the Blackfoot River at an outfall located near the eastern end of the north bank.

The pond is located along the south bank of the Blackfoot River and, based on historical photographs, was constructed in the former Blackfoot River channel. The focus of the Site Characterization is to 1) collect a water sample from the pond, sediment samples from the pond and Blackfoot River, and fill material/sediment samples from the berm; 2) assess physical characteristics of the sediments/fill; and, 3) analyze sediment/fill samples for PCBs and EPH. Sample analyses will be conducted by the U.S. Environmental Protection Agency (EPA) laboratory in Denver, Colorado.

DEQ shall repair any damage to the Site to the extent such damage arises out of the Site Characterization work performed by the DEQ and Olympus.

2.1 Project Objectives

The objectives of this sampling plan are to assess the chemical quality and physical characteristics of pond sediment and berm fill material, ground water quality in the berm adjacent to the pond, and chemical quality of sediments in the Blackfoot River. The data will be used to prepare an engineering evaluation/cost analysis (EE/CA). The EE/CA will include a description of cleanup alternatives for PCB and EPH impacted and a conceptual design for

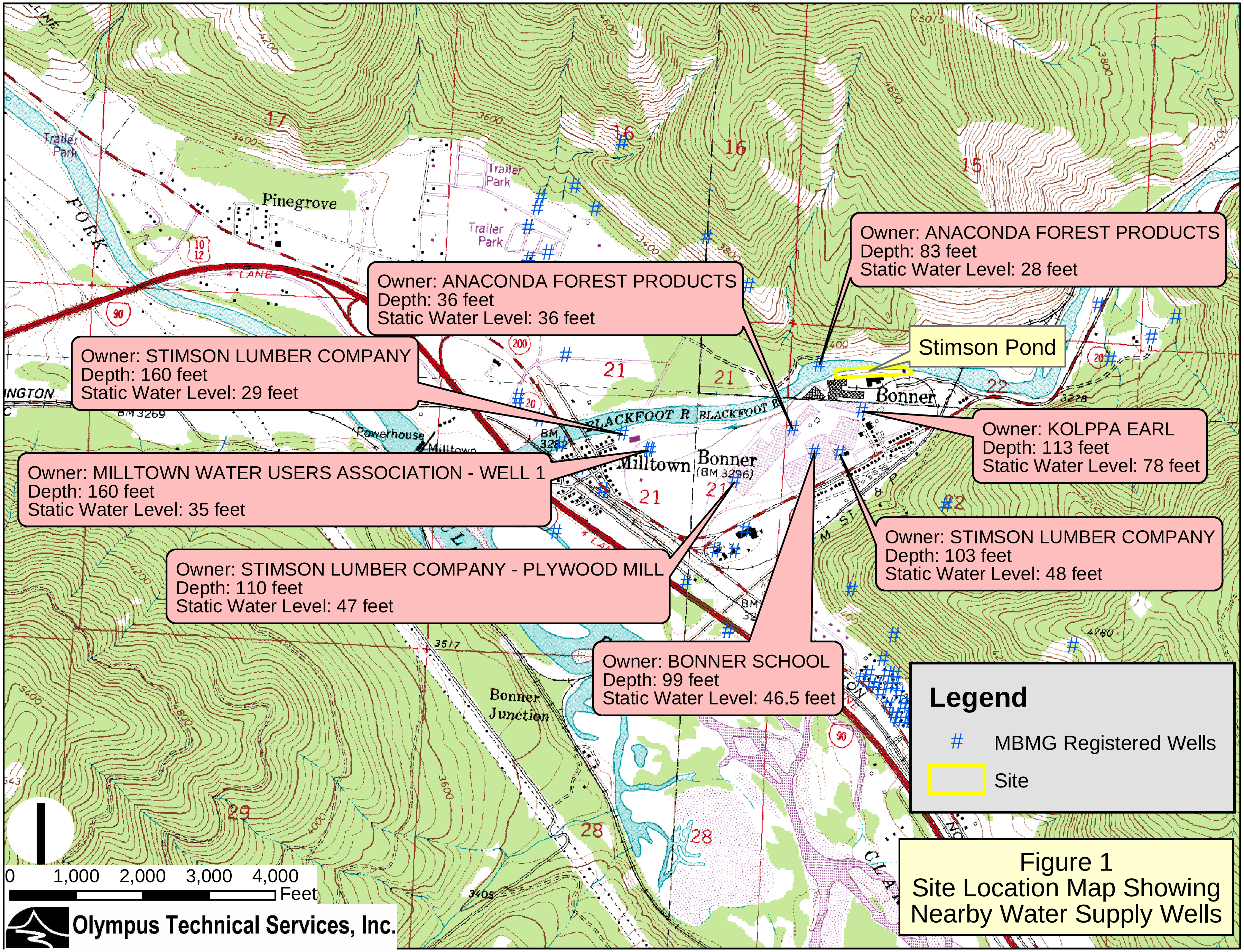


Figure 1
Site Location Map Showing Nearby Water Supply Wells

removing the remaining berm along the Blackfoot River..

Geotechnical data gathered during this investigation may also be used by the U.S. Army Corps of Engineers (USACE) to assess the stability of the berm as the Blackfoot River is lowered by removal of the Milltown Dam. Subsurface soil samples will be provided to USACE personnel for assessment.

2.2 Site Setting

2.2.1 Location and Topography

The Site is located in the Blackfoot River valley at an elevation of approximately 3,260 to 3,295 feet above mean sea level. Regional geography is characterized by steep mountainous terrain with vertical relief of up to 3,000 feet. The Site occupies relatively flat terrain along the south bank of the Blackfoot River. Based on historical photographs, the pond was constructed in the former channel of the Blackfoot River. A dike or berm separates the pond from the Blackfoot River.

2.2.2 Surface Water Hydrology

The Site is located on the south bank of the Blackfoot River. The Blackfoot River drains an area of approximately 2,290 square miles upstream from the Site and flows to the west in this area. The Site is located approximately 5,580 feet upstream (east) of the confluence with the Clark Fork River. The USGS Bonner gaging station is located approximately 5.5 miles upstream of the Site on the Blackfoot River. Stream flow records at that station are available for the periods of 1899 to 1905 and 1940 to present. Stream flow has ranged from approximately 200 to 19,200 cubic feet per second over the period of record.

2.2.3 Geology

The geology in the region has been summarized in a geologic map by Lewis (1998). The area is characterized by folded and faulted sedimentary rocks of Pre-Cambrian age. The structures are related to Sevier style thrust faults that trend northwest-southeast. The McNamara Formation, Bonner Quartzite, Mount Shields Formation, and Shepard Formation of the Belt Supergroup form the local bedrock at the Site. These formations are composed of interbedded argillite, siltite, and quartzite. The bedrock is exposed on the north bank of the Blackfoot River across from the Site. Quaternary age alluvial sediments and anthropogenic fill overlie the bedrock at the Site.

2.2.4 Hydrogeology

Information regarding site hydrogeology was obtained from the Montana Bureau of Mines and Geology (MBMG) Ground Water Information Center (GWIC). There are 183 GWIC registered wells located within one mile of the Site. The nearest registered wells and their reported total depth and static water level are shown on Figure 1. The well locations in GWIC are often approximate and cannot be relied on without field checking.

GWIC provided drilling logs for some of the wells located within a one mile radius of the Site; available logs indicate that the wells are completed in alluvial clay, sand and gravel. The maximum total depth of the wells located within one mile of the Site is reported to be 240 feet below ground surface (BGS), and the median total depth of the wells is reported to be 95 feet BGS. The maximum depth to static water level of the wells is reported to be 118 feet BGS, and the median depth to static water level of the wells is reported to be 48 feet BGS. The minimum total depth and minimum depth to static water levels of the wells was reported as zero; however, if no data are available the minimum depths are reported as zero, and the minimum depth data are unreliable.

Ground water quality data for a ground water sample collected from one of the Stimson Lumber Company wells was obtained from GWIC. The sample was collected on November 14, 2000 by MBMG staff and analyzed for major ions, trace elements, and basic water quality parameters. The analytical data for the ground water sample were compared to federal and state drinking water quality standards. Concentrations of analytes and other water quality parameters were detected at concentrations or levels below applicable water quality standards.

A hydrogeologic investigation was conducted by PBS&J (formerly known as Land & Water Consulting) in an area approximately 100 feet west of the cooling pond to assess impacts from a hydraulic oil release in that area. The investigation (Land & Water, 2003) disclosed that a water table aquifer occurs in unconsolidated alluvium with the water table surface at depths ranging from 13 to 26 feet below ground surface. Ground water flow was measured to be to the south, away from the Blackfoot River. This indicates that this reach of the Blackfoot River was losing water to the aquifer at the time of the investigation. The Milltown Reservoir water level was lowered in the Spring of 2006, after the hydrogeologic investigation, and Blackfoot River levels have declined approximately 8 feet since that time. This may impact ground water flow direction in the area. Ground water monitoring related to the hydraulic oil release is ongoing.

2.2.5 Land Use and Population

Surrounding land is used for commercial and residential purposes. The Bonner Mill, consisting of warehouses, buildings, and log and chip storage areas, is located south of the Site. The nearest residences are located on or adjacent to Montana Highway 200, located approximately 1,000 feet southeast of the Site. Approximately 61,000 people live within a 20-mile radius of the Site.

2.2.6 Site Development History

Information regarding development of the Site was obtained from past and current Stimson employees. The employees reported that the pond was built sometime after 1905 and before 1940. They reported that the pond used to be periodically dredged, and that the practice of placing logs in the pond prior to debarking continued into the early 1970s.

A comparison of historical and more recent photos suggests that the embankment was built onto the historical river bed as shown on Figures 2 and 3. Timber crib structures (cribs) were constructed in the river for sawmill operations as shown on the historical photograph on Figure 2. The berm was apparently constructed over the cribs and several cribs are visible in the berm bank.

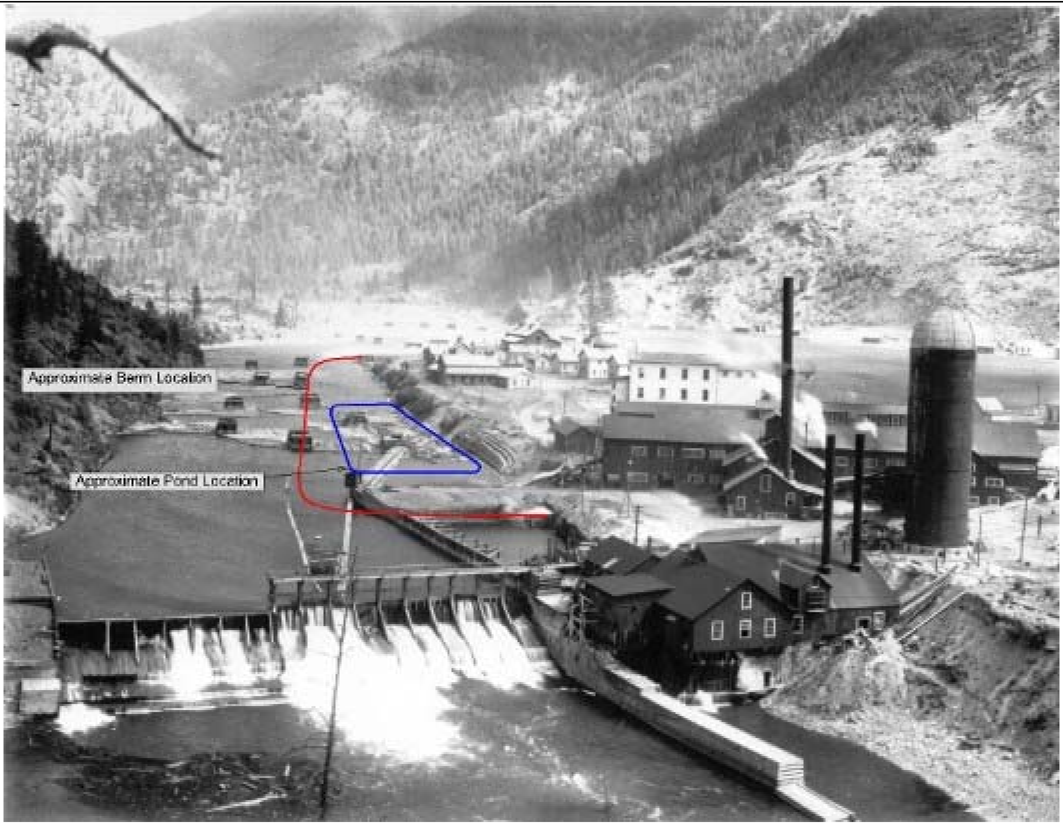


Figure 2. Historical photograph of project area, pre-Milltown Dam, 1900's.

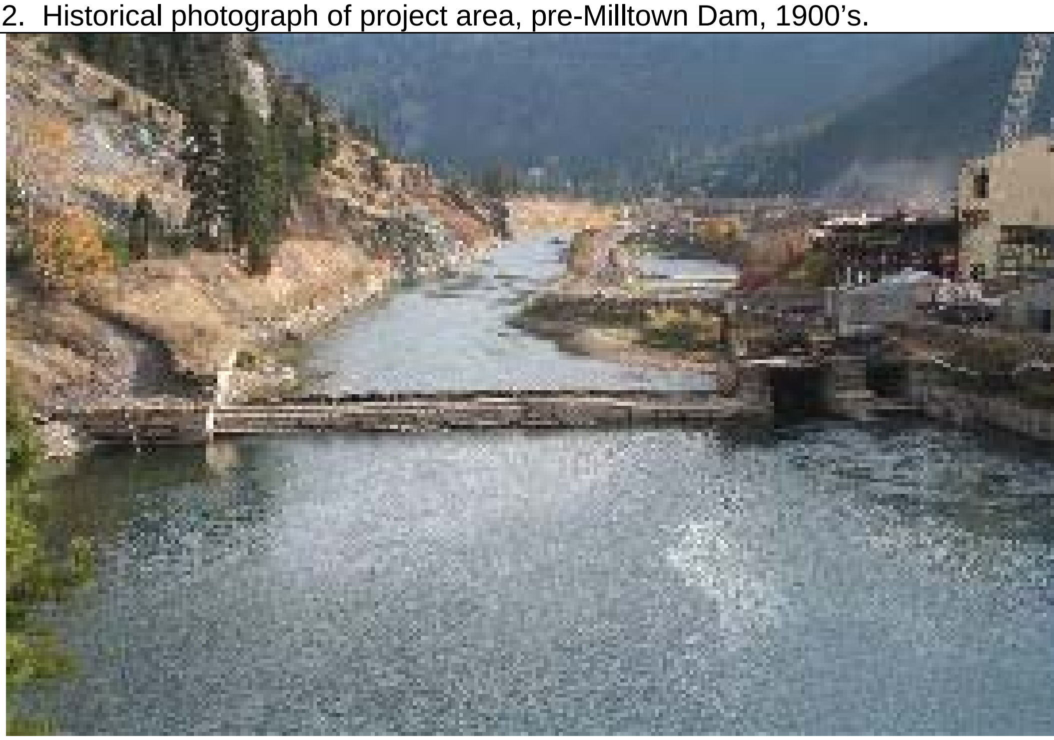


Figure 3. Stimson cooling pond embankment, November 2005

3.0 FIELD SAMPLING PLAN

The field sampling plan addresses constituents of concern, identifies action levels that field sampling and analytical methods will achieve, describes sampling approaches, and presents field sampling procedures. All field work will be conducted under the guidance of a site-specific health and safety plan (Appendix A).

3.1 Constituents of Concern

The cooling pond has been used to cool boiler blow down water and as a basin for yard runoff and NCCW. Because the history of discharge to the pond is not well documented, a broad range of potential contaminants was assessed during an initial phase of investigation conducted in March 2006 (Olympus, 2006). At that time, continuous sediment samples were collected from four borings completed at various locations as shown on Figure 4. The soil borings were located with the intent to characterize sediment at the pond outlet (B1), central pond area (B2), and pond influent areas (B3 and B4).

Sediment samples were logged in the field and selected samples were submitted to Northern Analytical for a wide variety of analyses, including extractable petroleum hydrocarbons (EPH), chlorinated herbicides, polychlorinated biphenyls (PCBs), organochlorine pesticides, semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), metals, reactivity, toxic characteristic leaching procedure (TCLP) herbicides, TCLP metals, TCLP pesticides, TCLP SVOCs, and/or TCLP VOCs. The most notable contaminants in the pond sediments are PCBs and extractable petroleum hydrocarbons as C11 to C22 range aromatics. The data were compared to screening levels, which were obtained from EPA and DEQ. The following compounds were detected at concentrations exceeding their reference screening levels.

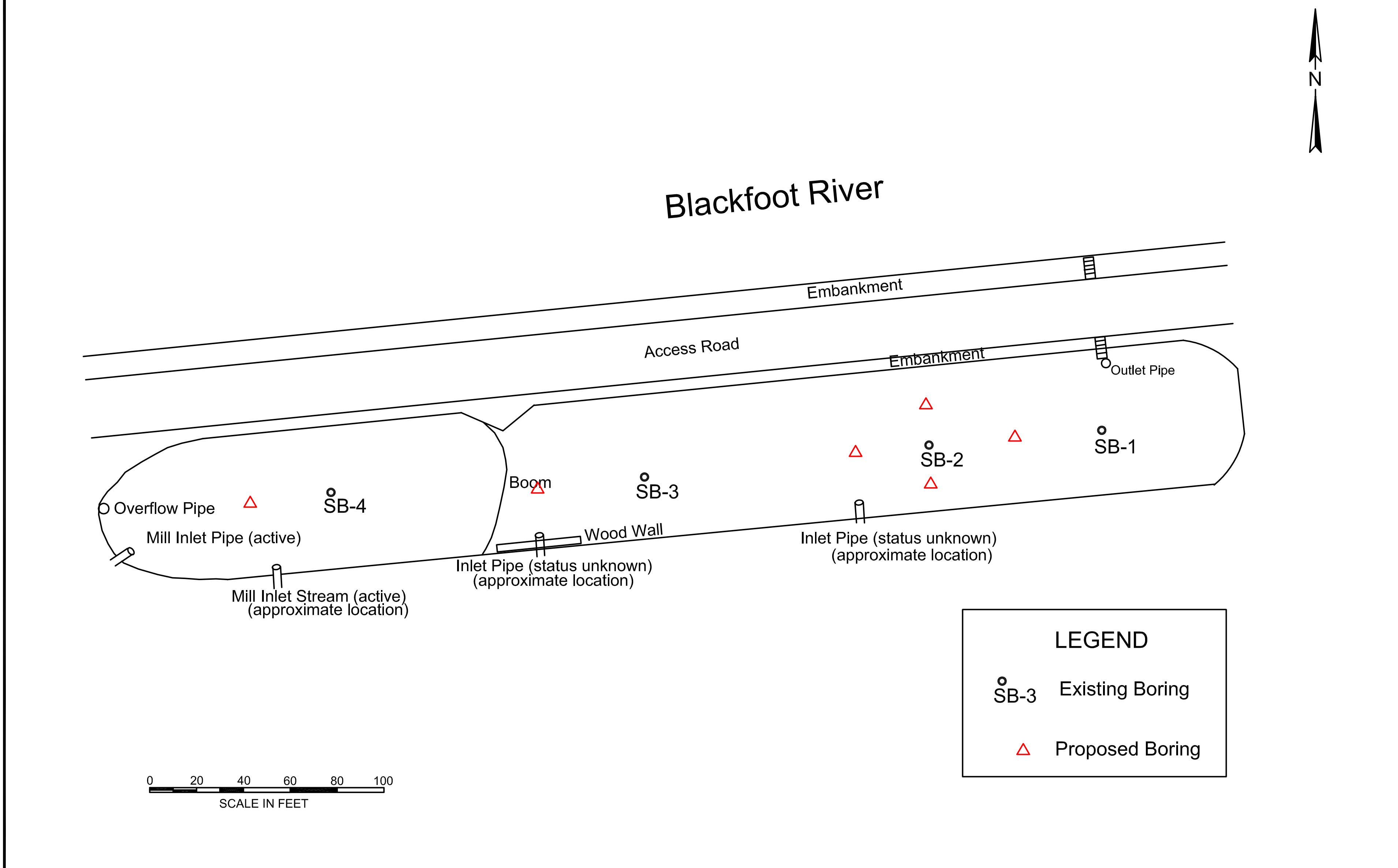
- EPH (dry weight) - C_{11} to C_{22} Aromatics: detected at concentrations from 180 milligrams per kilogram (mg/Kg) to 490 mg/Kg in samples collected from soil borings B1, B2, B3, and B4 (DEQ risk-based screening level of 100 mg/Kg);

- EPH (dry weight) - Total Extractable Hydrocarbons: detected at a concentration of 7,400 mg/Kg in a sample collected from soil boring B2 and at a concentration of 5,900 mg/kg in a sample collected from soil boring B3 (DEQ risk based screening level of 5,000 mg/Kg);

- PCBs (dry weight) - Aroclor-1254: detected at concentrations ranging from 0.55 mg/Kg to 65 mg/Kg in samples collected from soil borings B1, B2, B3, and B4 (EPA Region IX preliminary remediation goal of 0.11 mg/Kg); and

- Total Metals (dry weight) - Manganese: detected at concentrations of 2,740 mg/Kg and 3,010 mg/Kg in samples collected from soil boring B4 (EPA Region IX preliminary remediation goal of 1,800 mg/Kg).

The data indicate that the PCBs and petroleum hydrocarbons are the primary contaminants and they are distributed throughout the pond sediments. Petroleum hydrocarbon compounds and PCBs were detected in every sample that was analyzed at concentrations above their respective screening levels. Although the data did not indicate that either areal or vertical “hot spots” or source areas occur within the pond sediment, one sample did contain a PCB concentration of 65 mg/kg, which exceeds an EPA regulatory threshold (50 mg/kg) that affects



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BORING LOCATION MAP
STIMSON POND

FIGURE
4

disposal options. Hydrocarbons present in the sediment have boiling points in the range of lubricating and hydraulic oils, although they are not entirely consistent with the lubricating and hydraulic oil chromatograms used as references by Northern Analytical.

Petroleum hydrocarbon releases have also been identified at the Stimson mill in the vicinity of the cooling pond and berm. Stimson has contracted with PBS&J in Missoula, Montana, to conduct various phases of subsurface investigation and corrective action and the data summary provided here was obtained from several Land & Water and PBS&J reports (Land & Water, 2003; PBS&J, 2005a; and, PSB&J, 2005b). Documented releases in the vicinity of the cooling pond and berm area appear to be related to historical spills of hydraulic oil from hydraulic circuits along the Log Processing Track. A hydraulic circuit consists of a reservoir tank, pump, relief valve, directional control valve, winch acting motor, connectors and lines. Two releases from these hydraulic circuits were located near the cooling pond within the subject project area as shown on Figure 5. These releases are referred to as the Fire Pond Lagoon Area releases.

The first Fire Pond Lagoon Area release was discovered in August 2002 when petroleum sheen was observed on standing water in the Fire Pond Lagoon, which is located west of the Cooling Pond. Stimson conducted a sediment subsurface investigation in 2002 to determine the hydrocarbon source and assess the extent of impact. The investigation documented the presence of EPH compounds and xylenes, although the samples were not analyzed for PCBs. Stimson removed 1,180 cubic yards of petroleum-impacted soils and wood fill material in a Phase I excavation completed in 2004. Petroleum impacted soil remained along the west boundary of the excavation due to the presence of buildings and piping and the remaining impacted soil was reportedly going to be removed following removal of the Stimson Dam. The soil had not been removed as of the date of this SAP. Light non-aqueous phase liquid (LNAPL) oil was detected on the ground water surface in the excavation and in a monitoring well (MW-2b) placed in the removal area following the excavation. Dissolved phased EPH was detected in ground water in this area prior to soil removal but was not detected in samples collected following the soil removal.

An additional area of hydraulic oil impact was identified by Stimson on the south side of the pond as shown on Figure 5. Soil samples collected in this area have contained elevated concentrations of extractable petroleum hydrocarbons and PCBs. Approximately 26 cubic yards of hydraulic oil-impacted soil and wood wastes were removed from this area when test pits were completed in June 2006. A soil sample collected from the test pit area prior to removal contained a PCB concentration of 30 mg/kg.

Based on the above described studies, the constituents of concern for this investigation are PCBs and EPH compounds. In addition to the constituents of concern, the study will also assess physical characteristics of the sediment and fill as they relate to material handling, salvage options, and river restoration purposes. These data will be shared with EPA and USACE for their assessment of berm stability.

3.2 Data Quality Objectives

Data Quality Objectives (DQOs) have been developed to ensure that data collection is of the correct type, quality, and quantity to support defensible Site decisions. DQO development was conducted following the EPA seven-step process (EPA, 2000a).

Figure 5.
Historical Hydraulic
Oil Releases

3.2.1 Problem Statement

The Stimson Cooling Pond and associated berm may be removed in the near future. Insufficient data is currently available regarding sediment and fill characteristics to assess handling and disposal options. One objective of this study is to evaluate the physical and chemical characteristics of sediment, fill material, and ground water so that handling and disposal requirements can be assessed should the pond and berm be removed. Ground water data quality is required to evaluate the need for water treatment during dewatering activities and to assess whether pond removal could cause contaminant migration to the Blackfoot River. The geotechnical data may also be used by USACE in their assessment of berm stability. A second objective is to assess potential impacts from PCBs and EPH compounds to the Blackfoot River sediment and pond discharge water as required by EPA – Denver.

The project is being conducted by the DEQ with the Stimson Lumber Company as a cooperating partner in that they are providing access to the Site. The project is subject to a restricted schedule because it has the potential to be a time-critical constraint on the Milltown Dam Removal Project. Site sampling is tentatively scheduled for the period from approximately October 23, 2006 through November 10, 2006. The final data summary report is due to the DEQ by December 31, 2006.

3.2.2 Decision Requirements

The primary study questions addressed by this sampling program are: 1) what are the restrictions on handling and disposition of the sediment and fill based on the presence of contaminants; 2) what are appropriate handling and disposal/salvage methods based on the physical characteristics of the sediment and fill;, 3) what is the quantity of sediment or fill material that will be used in river bank restoration once the material is removed; and, 4) are the PCBs and EPH compounds in the pond sediment adversely impacting sediment and water quality in the Blackfoot River. The most stringent restrictions could apply should the sediment be classified as a Toxic Substance and Control Act (TSCA) waste and sample collection and analysis are needed to assess those characteristics. Petroleum hydrocarbon compounds may also pose health or environmental threats that would require that the sediment be handled in a controlled manner, be it disposal in a constructed repository or a municipal landfill.

3.2.3 Decision Inputs

Screening levels are used to evaluate the sediment and fill quality relative to potential health threats associated with uncontrolled disposal of the sediment containing PCBs and EPH constituents. The screening levels presented here are not to be considered as cleanup goals, but as concentrations at which further consideration is necessary. Development of screening levels here ensures that appropriate analytical methods are used.

The DEQ has calculated risk-based screening levels (RBSLs) for corrective action guidance for petroleum releases (DEQ, 2003). The RBSLs are limited to petroleum hydrocarbon compounds common to petroleum release sites. The RBSLs assess human health risk from direct contact to the compounds in soil as well as leaching of those compounds from impacted soil to ground water. These RBSLs can be used to identify appropriate disposal methods for impacted soil and sediment. The RBSLs will be used as the screening level for EPH compounds for which they have been developed. The analytical method, practical quantitation limit (PQL), and RBSLs are summarized in Table 1. The selected method has a PQL which is adequate for comparison to RBSLs.

The EPA (EPA, 2004) has adopted preliminary remediation goals (PRGs) that are used as a conservative screening level to assess whether contaminants may pose health threats. The DEQ often uses PRGs as screening levels for compounds that do not have RBSLs and they will be used in that capacity for this project. For this study and Site, EPA Region 9 PRGs for residential soil will be used as the PCB screening level. This level is conservative in that it is less than the regulatory standards that affect disposal method. The sediment and fill will be analyzed for PCB concentrations on a dry-weight basis. The analytical methods, PQL, and screening levels are summarized in Table 1.

Sediment and fill material physical characteristics will be used to evaluate potential disposal and salvage options. Salvage options include use of the material as compost, clean fill, or streambank and streambed materials for river restoration purposes. Soil samples will be logged in the field for physical characteristics following visual-manual procedures of ASTM D 2488-00.

3.2.4 Study Boundaries

The study includes sediments that have been deposited in the cooling pond since its construction and fill material placed as a berm on the west, east, and north sides of the pond. The bermed area extends beyond the immediate vicinity of the pond on the east side, to include all fill material placed in the suspected historical bed of the Blackfoot River to a distance of approximately 500 feet east of the pond as shown on Figure 6. The subject area, including the pond, has dimensions of approximately 1200 feet by 150 feet and covers an area of approximately 180,000 square feet. The pond has dimensions of approximately 470 feet by 75 feet and covers an area of approximately 33,000 square feet. The water depth is variable, ranging from less than 1 foot in the western portion of the pond to at least 9 feet in the eastern portion of the pond at the time of the pond sediment characterization field work (Olympus 2006). The pond surface has dropped approximately 2 feet since that time as observed during a site visit by Olympus personnel on September 11, 2006. Water generally enters the pond from several locations along the southern bank and is discharged to the Blackfoot River at an outfall located near eastern end of the northern bank of the pond, although the pond wasn't discharging through the outfall on September 11, 2006.

3.2.5 Decision Rule

Initial screening of the samples will be on a judgmental rather than statistical basis. The sample results will be individually compared to screening levels to assess where screening levels may be exceeded. Any exceedance of the screening levels will be evaluated on a case-by-case basis to identify potential restrictions on handling or disposal.

3.2.6 Acceptance Criteria

The data will not be statistically evaluated during this study and acceptance will be based on direct comparison of individual datum to screening levels.

Table 1. Target Analyte List and Screening Levels

Target Analyte	Analytical Method	Practical Quantitation Limit	Screening Level
Extractable Petroleum Hydrocarbons	Mass. Method		
C_9 to C_{18} Aliphatics		10 mg/kg	100 mg/kg RBSL
C_{19} to C_{36} Aliphatics		10 mg/kg	2,500 mg/kg RBSL
C_{11} to C_{22} Aromatics		10 mg/kg	70 mg/kg RBSL
PCBs	SW 8082		
Aroclor-1016		0.033 mg/kg	0.22 mg/kg PRG
Aroclor-1221		0.033 mg/kg	0.22 mg/kg PRG
Aroclor-1232		0.033 mg/kg	0.22 mg/kg PRG
Aroclor-1242		0.033 mg/kg	0.22 mg/kg PRG
Aroclor-1248		0.033 mg/kg	0.22 mg/kg PRG
Aroclor-1254		0.033 mg/kg	0.22 mg/kg PRG
Aroclor-1260		0.033 mg/kg	0.22 mg/kg PRG

Notes: Screening levels are based on the following sources:
RBSL indicates DEQ Tier 1 Risk-Based Screening Level for surface soil <10 feet to ground water (DEQ, 2003)
PRG indicates EPA Region 9 Preliminary Remediation Goal for residential soil (EPA, 2004)

Figure 6.
Study Area Boundary

3.2.7 Sampling Plan

The objectives of this sampling plan are to assess the chemical quality and physical characteristics of pond sediment and berm fill material, surface water quality in the pond, ground water quality in the berm adjacent to the pond, and chemical quality of sediments in the Blackfoot River. The number of samples for the various media, analyses, and quality assurance/quality control samples are summarized on Table 2.

Table 2. Sample Collection Summary

	Number of Samples			
Sample Type	Soil – EPH	Soil – PCB	Water – EPH	Water - PCB
Natural Samples				
Pond Sediment	51	51		
Pond Water			1	2
Blackfoot River Sediment	2	2		
Berm Fill Material	24	24		
Ground Water Samples			2	2
Background Sample	1	1		
Total Natural Samples	78	78	3	4
QA/QC Samples				
Field Duplicates	4	4	1	1
Equipment Rinsate Blanks			5*	5*
Total QA/QC Samples	4	4	6	6
Total Samples	82	82	9	10

* Note: Four of the equipment rinsate blanks are generated from soil sampling.

3.2.7.1 Pond Sediment Sampling

One sample (B2-S-2) collected during the March 2006 cooling pond sediment investigation contained PCBs at a concentration greater than 50 mg/kg. The 50 mg/kg concentration is a regulatory limit that affects disposal options. PCBs were detected in the thirteen other sediment samples collected from the pond in March 2006 at concentrations ranging from 0.22 to 36 mg/kg. Additional pond subsurface sample collection is needed to delineate the extent of PCBs in pond sediment at concentrations above 50 mg/kg.

Expected sample locations are shown on Figures 4 and 7, although locations may be adjusted in the field based on sample observations. Four borings will be located around the March 2006 boring SB-2, from which a sample PCB concentration exceeded 50 mg/kg. Continuous samples will be collected from these borings and each sample will represent a depth interval of no more than two feet. This sample interval is relevant for excavation purposes, in that removal and material sorting can be conducted to this level of precision. These data will be used to estimate the volume of sediment above 50 mg/kg that requires disposal at a TSCA landfill. One boring will be located near the center of the pond to evaluate a potential PCB source related to

Figure 7
Proposed Sample Locations

an inlet to the pond in that area. Continuous samples will be collected from this borings and each sample will represent a depth interval of no more than two feet. One boring will be located near the western end of the pond to evaluate a potential PCB source related to an inlet to the pond. Continuous samples will be collected from this boring and each sample will represent a depth interval of no more than two feet.

Borings will be located in the field using a combination of a hand-held global positioning system (GPS) receiver and relative shore-line measurements. With the exception of the westernmost boring, subsurface sediment samples will be collected using a core drilling rig staged on a barge. The pond has been draining since the water level in the Blackfoot River has been lowered and the water depth is too shallow to float a barge in the western end of the pond. A hand auger will be used to collect a sample at the westernmost sample location. Depending on field conditions, the hand auger boring will be advanced to a total depth of up to 2 feet below ground surface. The drilled borings will be advanced to the depth of native alluvium or the point of drill rig refusal, whichever occurs first. Samples will be collected using decontaminated split-tube, Shelby tube, or piston sampling devices, depending on sediment conditions. Continuous core samples will be collected to the maximum extent practicable given sediment conditions and available sample collection devices. The samples will be logged in the field for physical characteristics in accordance with ASTM D 2488-00. The core from each boring will be divided into discrete samples based on observed sediment characteristics. Samples will be collected at a maximum of two-foot intervals for laboratory analysis. The borings will be abandoned and sealed by backfilling with bentonite chips or pellets.

3.2.7.2 Berm Sampling

The pond is bounded on the north, east, and west sides by an artificial berm that appeared to have been placed in the historical river bed as shown on Figures 2 and 3. A topographic survey of the berm was prepared by Missoula Blueprint using aerial photographs acquired on April 22, 2004. The topographic map is shown on Figure 8. Based on the topographic survey, the depth of fill appears to be at least 20 feet across the entire berm area. Fill depth estimation and fill quality assessment will be completed by collection of subsurface soil samples from soil borings and test pits.

Soil borings will be completed using a sonic drill rig at the locations shown on Figure 7, although locations may be changed based on field observations. Borings will be advanced to the base of the fill, which is estimated to be between 20 and 25 feet below ground surface. Continuous core samples will be collected to the maximum extent practicable given sediment conditions. The samples will be logged in the field for physical characteristics in accordance with ASTM D 2488-00. The core from each boring will be divided into discrete samples based on observed sediment characteristics. Unless field observations, such as visible oil staining, indicate additional samples are needed, two samples will be collected from each boring and analyzed for PCBs and EPH. Sample collection criteria will be based on observations regarding unique lithologies or fill material and the presence of ground water.

Test pits may be excavated with a backhoe depending on the drilling results. Test pits may be needed if there is poor sample recovery in certain areas or if core data are insufficient to adequately assess material characteristics. If test pits are completed, the locations will be selected based on results obtained during the drilling program. Samples collected from the test pits will be logged in the field for physical characteristics in accordance with ASTM D 2488-00.

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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
STIMSON LUMBER POND
BONNER, MONTANA

Olympus Technical Services, Inc.

TOPOGRAPHIC CONTOUR
MAP OF SITE AREA

FIGURE
8

Unless field observations indicate additional samples are needed, one sample will be collected from each test pit and analyzed for PCBs and EPH.

3.2.7.3 Surface Water Sampling

The pond is not currently draining to the Blackfoot River from the outlet. A seep was observed in the Blackfoot River bank near the western end of the pond as shown on Figure 7 during a Site visit on September 11, 2006, and the pond may be leaking in this area. Two surface water samples will be collected from the pond, one near the center of the pond and one at the outlet near the eastern end of the pond. The samples will be collected directly into sample jars. The samples will be analyzed for PCBs and EPH.

3.2.7.4 Ground Water Sampling

Ground water monitoring wells will be constructed in two of the sonic drill borings located in the berm adjacent to the cooling pond as shown on Figure 7. The wells will be constructed of 2-inch diameter threaded PVC well casing and factory slotted screen. The annulus between the well screen and boring wall will be backfilled with Colorado Silica Sand. The annulus above the well screen will be backfilled with bentonite chips. A flush-grade well monument will be cemented into place at the ground surface. The wells will be developed by surging and bailing or pumping to ensure adequate hydraulic communication with the aquifer.

Ground water samples will be collected from the wells at least 24 hours after development is complete. Samples will be collected with disposable, polyethylene bailers. The wells will be purged of at least three well volumes prior to sample collection. Field parameters (pH, temperature, dissolved oxygen, and specific conductivity) will be measured during purging and samples will not be collected until those parameters have stabilized. Ground water samples will be poured directly from the bailers into sample jars. The samples will be analyzed for PCBs and EPH.

3.2.7.5 Blackfoot River Sediment Sampling

Two sediment samples will be collected from the Blackfoot River downstream from the outfall of the cooling pond at the locations shown on Figure 7. The samples will be collected using a decontaminated scoop or hand core sampler and placed directly into sample jars. The samples will be analyzed for PCBs and EPH.

3.2.8 Background Soil Sampling

The pond represents an artificial environment that receives sediment from sources at the Stimson Lumber Company and the berm is constructed from fill materials. The analytical results from the berm and pond sediment samples will be compared to EPA Region 9 PRG screening levels rather than background chemistry. The Blackfoot River has the potential for there to be up-stream sources of contaminants and one background sediment sample will be collected from a location to be selected in the field that is approximately 3300 feet upstream from the berm. The sediment sample will be analyzed for PCBs and EPH.

3.3 Sampling Protocols

3.3.1 Field Procedures

All field activities will be conducted in accordance with the standard operating procedures (SOPs) presented in Appendix B. The SOPs cover sampling methods; sample preservation; custody, quality assurance/quality control (QA/QC) samples and procedures; equipment and personnel decontamination; and sample designation and handling.

3.3.1.1 Equipment Decontamination

All equipment will be decontaminated before collection of each sample unless it is new, pre-decontaminated equipment in commercial packaging (e.g. bailers). Equipment decontamination consists of a tap water rinse, soap and tap water wash, and tap water rinse followed by air drying. All equipment will also be decontaminated before leaving the site to prevent off-site transport of contaminants. Decontamination wastes will be disposed of at the sample locations.

3.3.1.2 Sample Designation and Labeling

Split samples will be provided, upon verbal request in the field, to Stimson Lumber Company in containers to be provided by Stimson and labeled by Olympus. A sample numbering system will be used to identify the project site, the sample medium (S for soil or sediment and W for water), and the specific sample location. The sample identifier will be the boring number, the letter S will indicate that the sample media is soil, and the specific sample location number will be sequentially assigned for each boring. For example, the uppermost sample collected from boring B1 will be assigned sample number B1-S-1.

Sample locations will be described in the field logbook and plotted on the site sketch. Samples will also be located with a hand-held global positioning system (GPS) using a NAD 83 Datum. All samples will be labeled in the field and will be documented with the date and time of sample collection, the sample number, any preservatives used, analyses requested, and the sampler's initials. A permanent marker will be used for labeling, and labels will be covered with clear tape and sealed and tagged.

3.3.1.3 Sample Preservation and Handling

Samples will be preserved immediately upon sample collection, if applicable. Sample preservation, containers, and holding times are listed in Table 3. All procedures strictly follow the appropriate protocols.

All samples will be stored in coolers with ice. Chain-of-custody records will be kept with the samples and custody seals will be placed on the coolers.

TABLE 3. SAMPLE PRESERVATION AND HOLDING TIMES AND ANALYTICAL METHODS AND DETECTION LIMITS

Measurement	Analytical Method (1)	Preservation	Holding Time	Sample Size/ Sample Container
Soil/Sediment Samples				
EPH	Mass. Method	Store at 4°C	7 days to extract, 40 to analysis	125 milliliter wide-mouth glass
PCBs	SW 8082	Store at 4°C	14 days to extract, 40 to analysis	125 milliliter wide-mouth glass
Water Samples				
EPH	Mass. Method	Store at 4°C, Preserve w/ HCl	14 days to extract, 40 to analysis	1,000 milliliter glass
PCBs	SW 8082	Store at 4°C	7 days to extract, 40 to analysis	1,000 milliliter glass

3.3.1.4 Documentation

All field sampling activities and non-sampling data collection will be recorded in the site log book. The field team leader is responsible for recording information including weather conditions, field crew members, visitors to the site, samples collected, the date and time of sample collection, procedures used, any field data collected, and any deviations from this SAP.

3.3.1.5 Post-Sampling Activities

All personnel must go through decontamination procedures when leaving a contaminated area. Personnel decontamination includes routine practices as well as emergency decontamination. All measures will be conducted in a manner to prevent the spread of potentially hazardous materials to clean areas.

All potentially contaminated fluids, sampling equipment, and personal protective materials generated on-site will be containerized and disposed of properly. All wastes will be managed according to Office of Emergency and Remedial Response (OERR) Directive 9345.3-02 "Management of Investigation Derived Wastes During Site Inspections" (EPA, 1991).

All samples will be either hand-delivered or shipped via commercial carrier to the laboratories under EPA chain-of-custody procedures. Samples will be shipped in coolers, which will be kept cool with ice packs and insulated with appropriate packing material. Custody seals will protect the integrity of the samples while in transit to the laboratory.

3.3.2 QA/QC Sampling

Quality assurance/quality control (QA/QC) samples to be collected will include field duplicates, equipment rinsate blanks, laboratory duplicates, and laboratory spikes at a frequency of 1 per 20 natural samples collected. The field duplicate and rinsate blank samples will be submitted blind to the analytical laboratory. The laboratory duplicate and laboratory spike samples will be labeled as LD and LS respectively. The QA/QC samples will be analyzed for the same parameters as the natural samples. The number and type of QA/QC samples are summarized on Table 2.

The duplicate samples will be generated by splitting a sample from one sampling location into two samples. The duplicate sample checks the precision of sampling data.

The equipment rinsate blanks will be collected by pouring laboratory-supplied deionized water through or over decontaminated sampling equipment into an appropriate container. The equipment rinsate blanks test for cross contamination related to sampling procedures.

3.4 Reporting

A soil characterization report will be prepared that includes a summary of characterization activities, sample location maps, test pit and boring logs, sample descriptions, and volume estimates. The data will be reviewed and recommendations made for additional work, if needed.

3.5 Schedule

The field sampling is scheduled to occur during October and November 2006. The field team will generally comprise a project scientist for drilling and will also include an equipment operator for test pits. Laboratory analyses will be completed within a four week period after completion of the field program. A draft soil characterization report will be submitted to the DEQ within four weeks of receipt of the analytical data. The final reports will be submitted within two weeks of receipt of DEQ comments.

4.0 QUALITY ASSURANCE PROJECT PLAN

Quality Assurance (QA) is defined as the integrated program for ensuring reliability of monitoring and measurement data. The QA program requires the generation of a site or project specific Quality Assurance Project Plan (QAPP). This QAPP describes quality assurance for the characterization of the Stimson Cooling Pond and Berm.

The QAPP addresses project management, quality assurance objectives, sampling procedures, sample custody, equipment operation, analytical procedures, data reduction, corrective action procedures, audit procedures, preventative maintenance, and references. Data quality objectives regarding action levels are addressed in Section 3.2 and data quality objectives specific to each sample area are addressed in Section 3.2.7.

4.1 Project Organization and Responsibilities

The members associated with the investigation at the Site are listed below with their titles and responsibilities.

<u>DEQ Project Officer – Keith Large</u>

The DEQ Project Officer monitors the performance of the contractor. The DEQ reviews and approves QA measures. The DEQ Project Officer consults with the Project and Quality Assurance Manager on any deficiencies and aids in the finalization of the resolution action. The DEQ Project Officer will consult with the Stimson Lumber Company Overseer on all matters.

<u>EPA Project Officer – Francis Tran</u>

The EPA Project Officer monitors compliance with EPA regulations.

<u>Stimson Lumber Company Overseer - John Chopot</u>

The Stimson Overseer monitors the performance of the Contractor and reports any observed deficiencies to the DEQ Project Officer or the Project and Quality Assurance Manager.

Project and Quality Assurance Manager – Alan Stine, Olympus

The Project Manager will be responsible for noting deficiencies and finalizing the resolution action. The Quality Assurance Manager will be the leader of the data review, data validation, and auditing requirements. The Quality Assurance Manager will be responsible for discovering QA problems and, as necessary, initiating corrective actions.

Laboratory Quality Assurance Manager – Mark Murphy, EPA

The Laboratory Quality Assurance Manager is provided a copy of the LAP to ensure that appropriate procedures are followed during sample analysis and data package preparation.

Field Team Members – Alan Stine, Kevin Rauch, John Driscoll, Fritz Durham, Tom Peterson, and Rob Mahr, Olympus

Responsible for implementation of the sampling procedures, sample custody, field equipment operation, maintenance, calibration, and standardization. Responsible for data management including data base construction and data entry after data have been analyzed and validated.

Stimson Lumber Company Onsite Coordinator- Jerry Skillings

Coordinates field activities with Stimson Lumber Company operations.

4.2 Quality Assurance Objectives

The ability of data to meet DQOs is evaluated with Data Quality Indicators (DQIs), including precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity. The DQI methodologies for this project are presented in Table 4.

Table 4. Data Quality Indicators

DQI	Definition	Determination Methodologies
Precision	The measure of agreement among repeated measurements of the same property under identical, or substantially similar conditions; calculated as relative percent difference (RPD), calculated as. $RPD = \frac{(S - D)}{(S + D)/2} x100$ where: S = first sample value (original); and D = second sample value duplicate. Perfect precision would result in 0 percent RPD.	Use the same analytical instrument/method to make repeated analyses on the same sample. Acceptable RPDs for laboratory duplicates are 35% for solids and 20% for water. Split a sample or collect collocated samples in the field and submit both for sample handling, preservation and storage, and analytical measurements. Acceptable RPDs for field duplicates will be based on subjective assessment.

Table 4. Data Quality Indicators, continued

DQI	Definition	Determination Methodologies
Bias	The systematic or persistent distortion of a measurement process that causes errors in one direction.	Use reference materials or analyze spiked matrix samples. Acceptance or rejection is based on the percent recovery (% R) of the laboratory matrix spike in each sample. For example, perfect recovery would be 100% and an acceptable range would be 75% to 125%. Acceptable bias varies for the different analytical methods and the specific analytical method objectives will apply.
Accuracy	A measure of the overall agreement of a measurement to a known value; includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations.	Use reference materials or analyze spiked matrix samples. Acceptance or rejection is based on the percent recovery (% R) of the laboratory matrix spike in each sample. For example, perfect recovery would be 100% and an acceptable range would be 75% to 125%. Acceptable accuracy levels vary for the different analytical methods and the specific analytical method objectives will apply.
Representativeness	A qualitative term that expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.	Assess whether sample collection activities in conformance with all protocols outlined in the SOPs. The field equipment rinsate samples are used to confirm that the equipment decontamination and sample handling have no effect on sample results and reported data.
Comparability	A qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made.	Compare sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols.
Completeness	A measure of the amount of valid data needed to be obtained from a measurement system.	Compare the number of valid measurements completed with those established by the task's performance/acceptance criteria. The measurement goal will be 80% completeness. This goal takes into account the inability of any sediment sampling method to achieve 100% retrieval.

Table 4. Data Quality Indicators, continued

DQI	Definition	Determination Methodologies
Sensitivity	The capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.	Establish the minimum concentration or attribute that can be measured by a method (method detection limit) or by a laboratory (quantitation limit) and compare to action levels. Applicable PQLs are listed in Table 1.

4.3 Sampling Procedures

The representativeness and quality of data collected for an environmental study depends on maintaining and following strict protocols for sampling activities. Detailed procedures for sample collection and handling are specified and documented in the FSP (Section 3.0) and corresponding SOPs (Appendix B).

4.3.1 Field Logbook

The field logbook is the written record of all data, observations, field equipment calibrations, samples, and chain-of-custody. All entries will be in waterproof ink. Any mistakes will be lined out with a single line and initialed by the person making the correction. At a minimum the entry shall include:

- purpose of sampling;
- location and description of sampling point;
- identification of sampling crew;
- time and identification of any visitors to the site;
- type, number, preservative, and volume of sample;
- date and time of sampling;
- sample identification on chain-of-custody;
- identification and type of any QA/QC samples;
- date and time of shipping;
- weather;
- field measurements; and,
- any deviations from SOPs or Work Plan.

4.4 Sample Control, Documentation, and Shipping

The SOPs for sample handling, shipping, and related matters are discussed in Section 3.3. The purpose of these procedures is to maintain the integrity of all samples during collection, transportation, analysis, and reporting.

4.5 Field Quality Assurance/Quality Control Samples

The following types of quality assurance/quality control (QA/QC) samples will be collected in the field and shipped to the lab. These samples will be shipped to the laboratory as blind QA/QC samples, identified as if they are normal environmental samples.

4.5.1 Field Duplicate

The field duplicates are split samples collected from the same sampling location identically and consecutively over a minimum period of time. These samples are prepared by collecting an aliquot of subdivided samples after appropriate mixing and homogenization has been performed. Field duplicates can be provided to Stimson at their request (split sample). Field duplicates will be collected at a minimum frequency of 1 per 20 samples for all media. Field duplicates will be used to assess precision.

4.5.2 Equipment Rinsate Blank

An equipment rinsate blank consists of deionized water poured through decontaminated field equipment. An equipment rinsate will be prepared at a minimum frequency of 1 per 20 samples for all media. Equipment rinsate blanks will be used to assess representativeness and to verify that decontamination of sampling equipment was complete.

4.6 Sample Custody

4.6.1 Chain-Of-Custody

A required part of any sampling and analytical program is the integrity of the sample from collection to data reporting. This includes the ability to trace the possession and handling of samples from the time of collection through analysis and final disposition. This documentation of the sample's history is referred to as chain-of-custody (COC). A sample is considered to be under a person's custody if it is in a person's physical possession, in view of the person after taken possession, or secured by that person so that no one can tamper with the sample. The components of the field COC (COC form, labels, and custody seals) and lab COC (COC record, sample login/logout, sample storage records, and disposal records) are described in this section.

4.6.2 Chain-Of-Custody Form

A COC form will be completed and accompany every sample. The form includes the following information:

- Project code;
- Project name;
- Samplers signature;
- Sample identification;
- Date sampled;
- Time sampled;

- Preservatives;
- Analysis requested;
- Remarks;
- Relinquishing signature, date, and time; and
- Receiving signature, date, and time.

4.6.3 Sample Labels

Sample labels are necessary to prevent misidentification of samples. Self-adhesive labels are used and include the following information:

- Sample identification;
- Sampler's initials;
- Sampling date;
- Sampling time; and
- Preservative.

4.6.4 Custody Seals

Custody seals are used to detect unauthorized tampering with samples following sample collection during shipment up to the time of analysis. Custody seals will be applied to the shipping containers when the samples are released from the sampler's custody.

4.6.5 Laboratory Custody

Laboratory custody will conform to procedures established for the Contract Laboratory Program (CLP). These procedures include:

- designation of sample custodian;
- correct completion of the COC form, recording of sample identification numbers, and documentation of sample condition upon receipt;
- laboratory sample tracking and documentation procedures; and,
- secure sample storage.

The sample will be delivered to the lab for analysis in order to perform requested analyses within the specified allowable holding times. The samples will be delivered to the person in the lab who is authorized to receive samples (laboratory sample custodian).

4.7 Equipment Operation, Maintenance, Calibration, and Standardization

All field and lab equipment will be operated, maintained, calibrated, and standardized in accordance with the EPA and manufacturer's recommended procedures. The SOPs (Appendix B) contain the field equipment operation, maintenance, calibration, and standardization procedures. The analytical method references contain the laboratory equipment operation, maintenance, calibration, and standardization procedures.

4.8 Analytical Procedures

The analytical methods to be used during the Site investigation are presented in Tables 1 and 3. Laboratory analysis of samples collected during the course of this study will be performed by labs that have established protocols and QA procedures that meet or exceed EPA guidelines. EPA approved methods will be used for all applicable parameters. The laboratory standards which must be met for the project are outlined in the LAP (Section 5).

4.9 Data Reduction, Validation, Evaluation, and Reporting

4.9.1 Data Reduction

Data reduction is performed in the laboratory in conformance with the procedures outlined in the applicable method references. When EPA methods are used, the applicable data reduction procedures in the EPA method are used.

4.9.2 Data Validation

The primary data validation activities are performed by the laboratory during reduction of the laboratory data. The laboratory will review all surrogate recoveries, method blank analyses and matrix spike/matrix spike duplicate samples to verify that the analytical methods were properly performed and that no machine contamination affected the sample results. If necessary, the laboratory validation process will result in "data qualifiers" with the presented data. Table 5 presents result qualifiers that may be used. Olympus validates data by reviewing the laboratory QA/QC data and verifying the completeness of the laboratory data validation process. Olympus will also review the laboratory precision with the results of any duplicate samples submitted to the laboratory as separate investigation samples. When applicable, data results presented with qualifiers will be reported as concentrations with "data qualifiers". Data qualifiers are derived from the "USEPA Contract Laboratory Program National Functional Guidelines Inorganic Data Review," (EPA, 1994) and the “USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review” (EPA, 1999).

Table 5. Data Qualifiers

U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.
J	The associated value is an estimated quantity.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a “tentative identification”.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The data are unusable. (Note: Analyte may or may not be present.)

Knowing the limitations of the data assists the data user when making interpretations. Data with limitations are usable for evaluation as long as the limitations are considered.

4.9.3 Data Evaluation

Data evaluation is performed in the office after data validation is complete. Data evaluation will be conducted to assess the DQIs in regards to meeting the DQOs.

4.9.4 Data Reporting

Data reporting begins with transferring the validated analytical results and field measurements to the computerized database. Olympus will use Microsoft Excel software for transferring data to the DEQ. Data reporting continues with a printout of the analytical results and field measurements database and the interpretation of the analytical results and field measurements. The QC Summary Results, validation summaries, and computerized database will be presented to the DEQ at the completion of the project.

4.10 Corrective Action Procedures

Lab equipment malfunctions are handled by the chemist according to the equipment specifications and EPA analytical method specifications. Lab QC samples (calibration samples, method blanks, matrix spike samples, laboratory control samples, and lab duplicates) will be handled according to the EPA analytical method specifications.

4.11 Audit Procedures

An internal audit of all field procedures will be performed by the Quality Assurance Manager prior to any field work. The internal audit will include a review of procedures selected for the sampling program, a review of the QA/QC samples required, and a review of training requirements. The lab is required to have written procedures addressing internal QA/QC.

An external audit of all field procedures will be performed at the discretion of the DEQ Project Officer. External audit reports with recommended corrective action will be submitted by the DEQ Project Officer to the Project and Quality Assurance Manager. The Stimson Lumber Company may also request a copy from DEQ.

4.12 Preventative Maintenance

Preventative maintenance of equipment is essential if project resources are to be used in a cost effective manner. Critical spare parts will be available in the field. These spare parts include batteries, and film. The laboratory should have all necessary spare parts available for instrument repair.

5.0 LABORATORY ANALYTICAL PLAN

This Laboratory Analytical Plan (LAP) describes laboratory requirements for analysis of samples collected during the site characterization. Analysis of solids (soil and sediment) and water will be conducted. All laboratory analytical work will follow the requirements listed in this document for the duration of the project. The LAP contains sections describing laboratory requirements, quality assurance requirements, and analytical methods.

5.1 Laboratory Requirements

The EPA laboratory in Denver, Colorado will be the project laboratory. The project laboratory will be supplied with this document and will be required to meet the baseline data quality requirements outlined for the project in this document. All analyses performed by the project laboratories will follow the analytical methods listed in Table 3.

5.1.1 Qualifications and Experience

The laboratory shall have a rigorous and thorough internal Quality Assurance/Quality Control (QA/QC) program that reviews and validates all data generated and reported for the project. The QA/QC plan should be available in a written format that reviews the processes and designates key QA individuals by name and defines their responsibilities. The plan should include strict internal sample custody procedures from the time of sample receipt. The plan shall provide details for identifying out of control laboratory analyses and corrective actions for these conditions. The laboratory shall have a set of internal standard operating procedures (SOPs) that outline the laboratory analytical methodologies derived from USEPA reference methods and provide the methods of data reduction to determine the reported concentrations. The laboratory must also provide storage of all raw data for a period of at least two years after completion of the analyses.

5.1.2 Subcontracting

If necessary, subcontracting portions of this work by the primary laboratories is acceptable for special analyses. However, the need for any subcontracting must be approved by both the DEQ Project Officer and the Olympus Project Manager. All laboratories involved in this project must abide by the LAP and the QAPP (Section 4). Sample custody procedures must be maintained with any subcontracted analyses. Olympus will generally send samples directly to laboratories that will provide the required analyses.

5.1.3 Confidentiality

The analytical results will be treated as strictly confidential and should not be discussed with any persons other than the Stimson Lumber Company Overseer unless identified by the Olympus Project Manager or approved by both the DEQ Project Officer and the Stimson Lumber Company Overseer.

5.1.4 Reporting Times

The analytical results will be reported within 30 working days of sample receipt by the laboratory. When possible, the sample holding, preparation, analysis and reporting times should be minimized.

5.1.5 Reporting Format

The data analyses will be performed in conformance with EPA methods referenced in Table 3. While the analyses are performed at Analytical Support Level (ASL) IV, the reporting package will be delivered with standard ASL III information to reduce the overall project costs and amount of paper generated. However, the project laboratory must maintain all raw data, including internal QA/QC data, to support generation of the Contract Laboratory Program (CLP) ASL IV data package, if requested. The laboratory must save the data for a minimum of two years following completion of the analyses. Prior to disposal of any archived data, the laboratory should contact Olympus, DEQ, and Stimson Lumber Company and obtain written permission to determine the final disposition of the data support material.

The data support package provided as a deliverable will include the following:

1. Cover letter documenting analytical protocols used.

2. Copies of completed chain-of-custody forms.

3. Cross-reference table of contractor and laboratory ID numbers.

4. Data summary tables (hard copy and magnetic media in a format to be negotiated between Olympus and the laboratory).

5. QA/Quality Control (QC) Summaries including Laboratory Control Samples (LCS), spikes, duplicates, and preparation blank results.

5.1.6 Report Transmittal

All data reporting deliverables are to be sent directly to Olympus Technical Services, Inc., 765 Colleen, Helena, Montana 59601, in care of Mr. Alan Stine, Project Manager.

5.2 Quality Assurance Requirements

The external mechanism used to monitor the precision and accuracy of laboratory analyses to generate environmental data is the analysis of field and laboratory quality control (QC) samples. The required field QC types and frequency are provided in the QAPP (Section 4). Laboratory QC requirements include method blanks, duplicates, laboratory control samples, matrix spike (MS) and matrix spike duplicate (MSD) samples. The QC requirements are to be performed 1 per 20 samples. The ranges for precision (duplicates) and accuracy (matrix spikes) acceptability are presented in the QAPP (Section 4). The method blank should have a reported value at the method detection limit.

Calibration procedures and sample preparation procedures are part of the analytical methods listed in Table 3. The calibration procedures should be documented in a calibration logbook for each machine. Any laboratory QA/QC performance audits will be initiated by the DEQ project officer. No audits are currently scheduled to be performed for this project.

If a dilution is necessary, both the original and dilution result must be delivered. Appropriate clean-up procedures must be followed to minimize matrix effects on detection limits.

5.3 Analytical Methods and Sample Custody

Analytical methods are summarized in Table 3. The project laboratories should contact the Project Manager, Mr. Alan Stine or the DEQ Project Officer, Mr. Keith Large for permission to deviate from the listed analytical methods for any of the project analyses. All such deviations shall be reported to Stimson Lumber Company.

5.3.1 Analytical Detection Limits

All instrumentation utilized for the project must be sensitive enough to meet the required detection limits to meet the data quality objectives defined in Section 3.2 and Table 3.

5.3.2 Sample Storage Requirements

The contracted laboratory is required to have a secured sample bank for storage of samples, digestates, and extracts. Original samples will be stored in the sample bank for a standard six month interval. All other forms of the sample to be analyzed will be stored in this area for the standard six month interval after analysis or to the end of the analyte holding time, whichever comes first. The sample storage must be maintained to provide Olympus with time to review data and request re-analysis, if necessary. At the end of six months time, the laboratory will be responsible for sample disposal.

5.3.3 Laboratory Internal Chain of Custody

A sample is physical evidence collected from a facility or from the environment representative of site conditions. An essential part of hazardous waste investigations is that samples and data results may be used as evidence in legal proceedings.

Laboratories performing analyses will use document control and chain-of-custody procedures as specified by the appropriate analytical method.

5.3.4 Sample Stream

In accordance with EPA procedures, field QC samples (duplicates, blanks, and equipment rinsates) will be treated in the same manner as the standard samples. This provides external QC checks of laboratory data results.

6.0 REFERENCES

DEQ, 2003, Montana Tier 1 Risk Based Corrective Action Guidance for Petroleum Releases

EPA, 1994, USEPA contract laboratory program national functional guidelines for inorganic data review. EPA 540/R-94/013.

EPA, 1996, Soil screening guidance: user's guide. Publication 9355.4-23

EPA, 1999, USEPA contract laboratory program national functional guidelines for organic data review. EPA 540/R-99/008.

EPA, 2000, Guidance for the Data Quality Objectives Process. EPA QA/G-4, EPA/600/R-96/055.

EPA, 2004, EPA Region IX Risk-Based Concentration Table.

Olympus 2006, Site Characterization Report, Stimson Lumber Company Cooling Pond, Missoula County, Montana, May 31, 2006. Prepared for DEQ.

Land & Water, 2003, Phase II Remedial Investigation, Fire Pond Lagoon, December 2003, Prepared for Stimson Lumber Company.

PBS&J, 2005a, Fire Pond Lagoon Corrective Actions Report, June 2005, Prepared for Stimson Lumber Company.

PBS&J, 2005b, Quarterly Monitoring Report – September 2005, Prepared for Stimson Lumber Company.

APPENDIX A

HEALTH AND SAFETY PLAN

Olympus Technical Services, Inc.

SITE HEALTH AND SAFETY PLAN

THIS HEALTH AND SAFETY PLAN IS TO BE USED IN CONJUNCTION WITH
OLYMPUS' CORPORATE HEALTH AND SAFETY PLAN
(To be completed by the Project Manager and the Site Health and Safety Officer.)

DATE OF COMPLETION 09/14/2006 OLYMPUS PROJECT # A1534

EMERGENCY INFORMATION (Attach map to nearest hospital)

Emergency Numbers

Fire 911 Ambulance 911 Hospital 911

Olympus Office 406/443-3087 Client Number 406/841-5039

Project Manager Alan Stine Olympus Contact Alan Stine

Site Health and Safety Officer Alan Stine

Client Contact Kieth Large

Site Address Stimson Lumber Company, Section 22, Township 13 North, Range 18 West

Location of Health and Safety Equipment In vehicle

SITE DESCRIPTION (Include location, area affected, topography, access, site control, boundaries & site map)

Stimson cooling pond and berm. The site is located along the south bank of the Blackfoot River. A levee separates the pond from the river and provides an access road around the pond. The pond collects boiler blowdown water and runoff water from the mill yard.

PROJECT PLAN (Include job tasks, hazardous substance information forms(s), & equipment being used on/near site)

Collect sediment samples from the pond using a core drill rig mounted on a barge. Collect berm fill material samples using a sonic drill rig. Install monitoring wells in selected berm borings and collect ground water samples from the monitoring wells. Collect sediment samples from the Blackfoot River. Collect a water sample from the pond. Lubricating oil and polychlorinated biphenyls have been identified at the site but may be present. Data sheets from US Coast Guard CHRIS Manual are attached.

SITE HEALTH AND SAFETY MEETING CHECK LIST

DATE 9/14/06 OLYMPUS PROJECT # A1534

HAZARD EVALUATION (See attachment A for assistance)

Exposure Hazard(s) (For PPE Purposes)

Substance	Concentration	Skin: Low	Skin: Moderate	Skin: High	Skin: Extreme	Inhalation: Low	Inhalation: Moderate	Inhalation: High	Inhalation: Extreme	Ingestion: Low	Ingestion: Moderate	Ingestion: High	Ingestion: Extreme
Lubricating Oil	1,000's mg/kg	X				X				X			
PCBs	10's mg/kg	X				X				X			

Other Hazards Slip, trip, and fall hazards. Hazards associated with working over water.

FIRE/EXPLOSION HAZARDS

Flash Point

- [ ] Dangerous - 100 F or Less
- [ ] Moderate - 100 F to 200 F
- [x] Low - 200 F or Above

LEL

UEL

Other

POSSIBLE HAZARDOUS REACTIONS

Stable ☐ Unstable ☐ Pyroforic ☐ Oxidizer ☐ Water ☐ Hazardous Polymerization ☐ Toxic Gas Generation ☐

Reaction Results From

Type of Decomposition Decomposes To

PPE PROTECTION

Job Tasks	Level of Protection
All tasks	Level D, latex or nitril sample gloves
	Life jackets when working over water

DECONTAMINATION/PPE DISPOSAL Dry decon if possible, otherwise wash and rinse. Containerization of all PPE and decontamination liquids.

AIR MONITORING

YES [x] NO [ ] To Be Done By: PID

(A) On entry before job begins YES [x] NO [ ] (B) During time in hazardous waste location YES [x] NO [ ]

If "YES" - Time Interval During sample collection

ELECTRICAL HAZARDS GFCI required for all electrical equipment

COMMENTS Be aware of potential for hazardous substances during sample collection and avoid direct contact.

ATTACHMENT A

References - for Hazard Evaluation

Chemical Hazard Response Information System (C.H.R.I.S.),
U.S. Department of Transportation and U.S. Coast Guard.

Dangerous Properties of Industrial Materials, Sax and Lewis.

NIOSH Pocket Guide to Chemical Hazards, U.S. Department
of Health and Human Services.

Definitions - for Exposure Hazard(s)

Low	-	Materials which on exposure would cause irritation but only minor residual injury even if no treatment is given.
Moderate	-	Materials which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.
High	-	Materials which on short exposure could cause serious temporary or residual injury even though prompt medical treatment were given.
Extreme	-	Materials which on very short exposure could cause death or major residual injury even though prompt medical treatment were given.

SITE HEALTH AND SAFETY MEETING CHECK LIST

Date:____________________ Job Number:____________________
Project Name:____
Field Location:____
Site Manager:____________________ Health & Safety Coordinator:____________________

Introduction of People ---------------- ( )
Work Scope ---------------------------- ( )
Level of Entry -------------------------- ( )
PPE to be Used ---------------------- ( )
Identify Hazards ---------------------- ( )
Equipment Being Used ------------- ( )
Site Specific Safety Rules ---------- ( )

Emergency Information

Telephone Numbers ---------------- ( )
Telephone Location ----------------- ( )
Hospital Directions/Map ----------- ( )
Escape Route ----------------------- ( )
Fire Extinguisher -------------------- ( )
First Aid Kit ---------------------------- ( )
Eyewash ------------------------------- ( )

General

Restrooms ---------------------------- ( )
Work Zones Delineated ------------ ( )
Decon/Demob Requirements ---- ( )
Onsite Personnel meet HSAM Requirements for Medical, Fit Test, & Training -------- ( )
Personnel have read Site Health & Safety Plan --------------- ( )
Communication Procedures ------ ( )

If Applicable

MSDS Onsite/Available ------------- ( )
Fit Testing ----------------------------- ( )
Confined Entry Permit ------------- ( )
Monitoring Equipment Calibrated ------------------ ( )

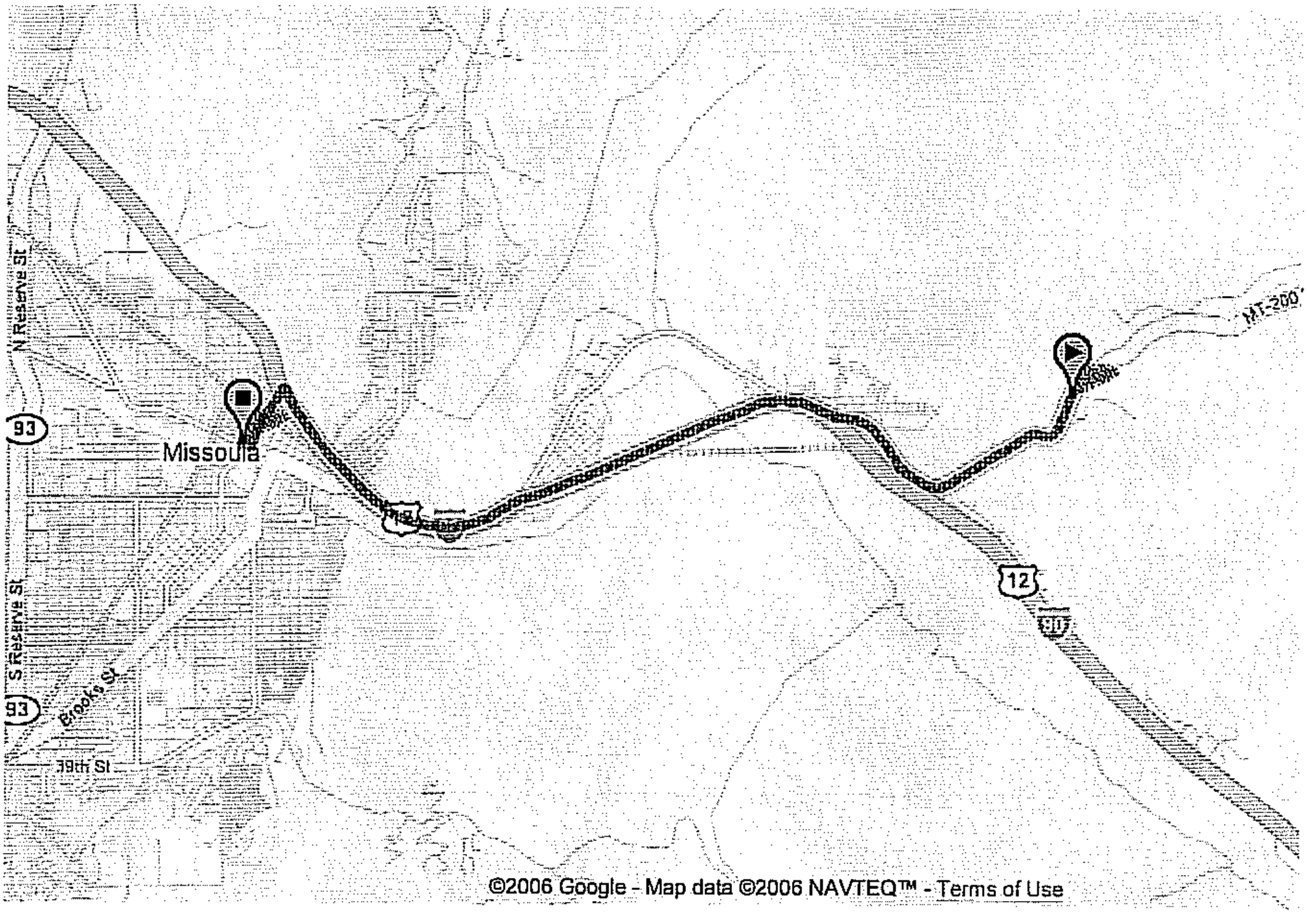
Personnel Present

____

Comments

____

Start **11000 Mt Highway 200 E**
Bonner, MT 59823
End **500 W Broadway St**
Missoula, MT 59802
Travel **8.6 mi (about 11 mins)**



Directions

1. Head **southwest** from **MT-200**	**2.3 mi** 3 mins
2. Bear **left**	**0.1 mi**
3. Take the **I-90 W** ramp	**5.3 mi** 5 mins
4. Take the **Orange St** exit **104**	**0.2 mi**
5. Turn **left** at **N Orange St**	**0.6 mi** 1 min
6. Turn **right** at **W Broadway St**	**477 ft**
7. Arrive at 500 W Broadway St Missoula, MT 59802	

These directions are for planning purposes only. You may find that construction projects, traffic, or other events may cause road conditions to differ from the map results.

OILS, MISCELLANEOUS: RANGE

ORG

Common Synonyms	Watery liquid	Colorless	Kerosene odor
Kerosine Kerosene Fuel oil No. 1 JP-1	Floats on water.		

Stop discharge if possible.
Call fire department.
Avoid contact with liquid.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Mechanical containment
Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Miscellaneous Hydrocarbon Mixtures
3.2 **Formula:** Not applicable
3.3 **IMO/UN Designation:** 3.3/1223
3.4 **DOT ID No.:** 1223
3.5 **CAS Registry No.:** Data not available

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Like kerosene

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Protective gloves; goggles or face shield.
5.2 **Symptoms Following Exposure:** Vapor causes slight irritation of eyes and nose. Liquid irritates stomach; if taken into lungs, causes coughing, distress, and rapidly developing pulmonary edema.
5.3 **Treatment of Exposure:** ASPIRATION: enforce bed rest; administer oxygen; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: wash with copious amounts of water. SKIN: wipe off and wash with soap and water.
5.4 **Threshold Limit Value:** Data not available
5.5 **Short Term Inhalation Limits:** Data not available
5.6 **Toxicity by Ingestion:** Grade 1; LD_{50} = 5 to 15 g/kg
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause slight smarting of eyes and respiratory system if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 1 ppm
5.11 **IDLH Value:** Data not available

6. FIRE HAZARDS

6.1 **Flash Point:** 100°F C.C.
6.2 **Flammable Limits in Air:** 0.7%-5%
6.3 **Fire Extinguishing Agents:** Foam, dry chemical, or carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** 444°F
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** 4 mm/min.
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 33

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 2990 ppm/24 hr/bluegill/TL_m/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** 53%, 5 days
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Light hydrocarbon distillate: 100%
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Open (flame arrester)

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Combustible liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	2
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	1
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	1
Aesthetic Effect	3
Reactivity	
Other Chemicals	0
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	0
Flammability (Red)	2
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** Not pertinent
12.3 **Boiling Point at 1 atm:** 392—500°F = 200—260°C = 473—533°K
12.4 **Freezing Point:** —45 to —55°F = —43 to —48°C = 230 to 225°K
12.5 **Critical Temperature:** Not pertinent
12.6 **Critical Pressure:** Not pertinent
12.7 **Specific Gravity:** 0.80—0.85 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 23—32 dynes/cm = 0.023—0.032 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** 47—49 dynes/cm = 0.047—0.049 N/m at 20°C
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** Not pertinent
12.12 **Latent Heat of Vaporization:** 108 Btu/lb = 60 cal/g = 2.51×10^5 J/kg
12.13 **Heat of Combustion:** —18,540 Btu/lb = —10,300 cal/g = -431.24×10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** Data not available

NOTES

POLYCHLORINATED BIPHENYL

PCB

Common Synonyms	Oily liquid to solid powder	Light yellow liquid, or white powder	Weak odor
PCB Chlorinated biphenyl Arochlor Halogenated waxes Polychloropolyphenyls	Sinks in water.		

Stop discharge if possible. Keep people away.
Avoid contact with liquid and solid.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
Extinguish with water, foam, dry chemical, or carbon dioxide.

Exposure

CALL FOR MEDICAL AID.

LIQUID OR SOLID
Irritating to skin and eyes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-water contaminant
Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Not listed
3.2 **Formula:** $(C_{12}H_{10-n})Cl_n$
3.3 **IMO/UN Designation:** Not listed
3.4 **DOT ID No.:** 2315
3.5 **CAS Registry No.:** 1336-36-3

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid or solid
4.2 **Color:** Pale yellow (liquid); colorless (solid)
4.3 **Odor:** Practically odorless

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Gloves and protective garments.
5.2 **Symptoms Following Exposure:** Acne from skin contact.
5.3 **Treatment of Exposure:** SKIN: wash with soap and water.
5.4 **Threshold Limit Value:** 0.5 to 1.0 mg/m³
5.5 **Short Term Inhalation Limits:** Data not available
5.6 **Toxicity by Ingestion:** Grade 2; oral rat LD_{50} = 3980 mg/kg
5.7 **Late Toxicity:** Causes chromosomal abnormalities in rats, birth defects in birds
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause severe irritation of eyes and throat and cause eye and lung injury. They cannot be tolerated even at low concentrations.
5.9 **Liquid or Solid Irritant Characteristics:** Contact with skin may cause irritation.
5.10 **Odor Threshold:** Data not available
5.11 **IDLH Value:** 5 to 10 mg/m³

6. FIRE HAZARDS

6.1 **Flash Point:** >286°F
6.2 **Flammable Limits in Air:** Data not available
6.3 **Fire Extinguishing Agents:** Water, foam, dry chemical, or carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Irritating gases are generated in fires.
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** Data not available
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** Data not available
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** Data not available

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
0.278 ppm/96 hr/bluegill/TL_m/fresh water
0.005 ppm/336-1080 hr/pinfish/TL_m/salt water
8.2 **Waterfowl Toxicity:** LD_{50} 2000 ppm (mallard duck)
8.3 **Biological Oxygen Demand (BOD):** Very low
8.4 **Food Chain Concentration Potential:** High

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** 11 grades (some liquid, some solids) which differ primarily in their chlorine content (20%-68% by weight)
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Open

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

II

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** ORM-E
11.2 **NAS Hazard Rating for Bulk Water Transportation:** Not listed
11.3 **NFPA Hazard Classification:** Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Solid
12.2 **Molecular Weight:** Not pertinent
12.3 **Boiling Point at 1 atm:** Very high
12.4 **Freezing Point:** Not pertinent
12.5 **Critical Temperature:** Not pertinent
12.6 **Critical Pressure:** Not pertinent
12.7 **Specific Gravity:** 1.3—1.8 at 20°C (liquid)
12.8 **Liquid Surface Tension:** Not pertinent
12.9 **Liquid Water Interfacial Tension:** Not pertinent
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** Not pertinent
12.12 **Latent Heat of Vaporization:** Not pertinent
12.13 **Heat of Combustion:** Not pertinent
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** Data not available

NOTES

APPENDIX B

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE G-1

FIELD LOGBOOK/PHOTOGRAPHS

Standard Operating Procedure
Field Logbook/Photographs (G-1)

Field Logbook

A separate field logbook will be used for each field task. Each logbook shall have a unique document control number. The logbooks will be bound and have consecutively numbered pages. The information recorded in these logbooks shall be written in indelible ink. The author will initial and date entries at the end of each day and a line shall be drawn through the remainder of the page. All corrections will consist of a single line-out deletion in indelible ink, followed by the author's initials and the date. No bound field logbooks will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. These bound logbooks, at a minimum, shall include the following entries:

1. A purpose and description of the proposed field task,
2. Time and date fieldwork started,
3. Location and description of the work area, including sketches if possible, map references and photographs, and sketches of well construction details, soils, pits, etc.,
4. Names and titles of field personnel,
5. Name, address and phone number of any field contacts,
6. Meteorological conditions at the beginning of fieldwork and any ensuing changes in these conditions,
7. Details of the fieldwork performed and field data sheets used (including document control numbers), with special attention to any deviations from the task-specific Sampling and Analysis Plan (SAP) or Standard Operating Procedures(SOPs),
8. All field measurements made,
9. Any field laboratory analytical results, and
10. Personnel and equipment decontamination procedures.

For any field sampling work, at a minimum, the following entries should be made:

1. Sample location and number,
2. Sample type (e.g., ground water) and amount collected,
3. Date and time of sample collection,
4. Split samples taken by other parties. Note the type of sample, sample location, time/date, name of person, person's company, any other pertinent information,
5. Sampling method, particularly and deviations from the SOP,
6. Suspected waste composition, including an estimate of the hazard level as being low or medium,
7. Documentation or reference of preparation procedures for reagents or supplies that will become an integral part of the sample (e.g., filters and preserving reagents), and
8. Sample preservation, handling, packaging, labeling, shipping information (e.g., weight), the shipping agent, and the laboratory where the samples will be sent.

After each day of fieldwork, all the bound logbooks will be locked up in a location accessible to the Quality Assurance Manager, such as the field office filing cabinet.

Photographs

Photographs will be taken of field activities using a camera-lens system with a perspective similar to the naked eye. Photographs should include a measured scale in the picture, when practical. Telephoto or wide-angle shots will not be used, since they cannot be used in enforcement meetings. The following items shall be recorded in the bound field logbook for each photograph taken:

1. The photographer's name, the date, the time of the photography and the general direction faced,
2. A brief description of the subject and the fieldwork portrayed in the picture, and
3. Sequential number of the photograph and the roll number on which it is contained.

PHOTOGRAPH LABELS

PHOTOGRAPH NUMBER:____________________
DATE:____________________________________
TIME:_____________________________________
DIRECTION:________________________________
PHOTOGRAPHER:___________________________
DESCRIPTION:______________________________
____
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STANDARD OPERATING PROCEDURE G-2

SAMPLE PACKAGING AND SHIPPING

Standard Operating Procedure
Sample Packaging and Shipping (G-2)

The following steps shall be followed when packaging and shipping environmental samples:

1. Collect the sample as stated in appropriate standard operating procedure (SOP).
2. Wipe the exterior of the sample container with appropriate decontamination solution while wearing the necessary personal protective equipment as specified in the site-specific Health and Safety Plan.
3. Attach the identification tag to the sample container. Place sample container in a 2-ml thick (or thicker) zip-lock polyethylene bag, one sample per bag. Position the sample container so the identification tag can be read through the bag, then seal the bag.
4. Place one or more bagged samples into a strong outside water-tight container, such as an ice chest or a DOT-approved fiberboard box.
5. Add ice and/or blue ice if required by the appropriate SOP.
6. Secure containers with noncombustible, absorbent, cushioning materials.
7. Secure the properly completed chain-of-custody form (see SOP G-4) to the inside of the ice chest lid in a plastic bag. The chain-of-custody form shall list only those samples contained in the ice chest.
8. Tape ice chest drain and ice chest closed using fiberglass tape and seal with several chain-of-custody seals.
9. Complete the air bill and Shipper's Certification for Restricted Articles/Dangerous Goods if required.
10. Label and address the ice chest.

Note: Bagging of samples and lining of coolers will not be necessary if samplers transport samples directly to the laboratory.

STANDARD OPERATING PROCEDURE G-3

FIELD QUALITY CONTROL SAMPLES

Standard Operating Procedure
Field Quality Control Samples (G-3)

Field Quality Control (QC) is a part of the project Quality Assurance/Quality Control program and is described in detail in the project specific Quality Assurance Plan. This Standard Operating Procedure (SOP) describes the purpose, preparation and collection frequency of field QC blanks and duplicate samples for aqueous matrices. QC samples will not be collected for soil samples because solid media is too heterogeneous. Table G-3.1 summarizes the field QC sampling requirements described in this SOP.

At least one set of field QC samples will be prepared for each sampling event. An event is defined by any of the following conditions:

1. The beginning of a new sampling round,
2. A significant change in either the sample type, matrix, or location, or
3. A change in any sample analysis parameter.

If the number of field QC samples taken does not equal to an integer multiple of the interval specified in Table G-3.1, use the next higher multiple. For example, if a frequency of 1 in 20 is indicated and 28 field samples are collected, then two field QC samples will be prepared.

All field QC samples shall be packaged and shipped with field samples to the laboratory in accordance to procedures outlined in SOP-G-2. Sample custody will be maintained according to procedures outlined in SOP-G-4. The text below describes the field QC samples for the aqueous matrix.

Field QC Samples

Trip Blank

A trip blank will be used to help identify cross contamination in a shipment of aqueous samples for analyzing volatile organic compounds (VOCs) only. Trip blanks will be prepared by the appropriate laboratory and in the appropriate containers using distilled/deionized (DS/DI) water. Trip blanks will be transported unopened to and from the field with field samples. One trip blank will be prepared for and sent with each shipment of samples for analyzing VOCs.

Equipment Rinsate Blank

Equipment rinsate blanks will be used to help identify possible contamination from the sampling environment or from sampling equipment, such as a bailer, collection container, or filter apparatus. Equipment rinsate blanks for field-filtered samples will be prepared by processing a representative amount of DS/DI water through the decontaminated sample collection equipment and filtering apparatus with a filter, then transferring the water to an appropriate sample container, and adding any necessary preservatives.

Equipment rinsate blanks for non-field filtered samples will be prepared by processing a representative amount of laboratory DS/DI water through the decontaminated sample collection equipment, then transferring the water to an appropriate sample container, and adding any necessary preservatives. Equipment rinsate blanks are required for all inorganic or organic constituents. Equipment rinsate blanks will be prepared daily, or once for every 20 samples collected, whichever is more frequent.

Field Blank

Field blanks provide a measure of various cross-contamination sources, decontamination efficiency, and other potential errors that can be introduced from sources other than the sample. A field blank is prepared by the same protocols as a normal sample, but is not exposed to any sampling equipment. A field blank is prepared in the field and consists of a representative amount of DS/DI and/or reagent-grade (analyte-free) water and any necessary preservatives. A field blank is contained in a sample bottle randomly chosen from each lot of bottles received from the supplier. Field blanks are required for all inorganic or organic constituents. Field blanks will be collected for each type of sample bottle at a frequency of 1 per 20 samples or once per sampling event, whichever is more frequent.

Field Duplicate

Field duplicates are co-located samples collected identically and consecutively over a minimum period of time and provide a measure of the total analytical bias (field and laboratory variance), including bias resulting from the heterogeneity of the replicate sample set itself. Field duplicates consist of two samples (one sample and one replicate) collected consecutively at the same location and placed in different bottles for separate analysis. Each duplicate will have its own sample number. The two samples will be sent to the laboratory and analyzed for identical chemical parameters. Field duplicate samples will be collected at a minimum frequency of 1 per 20 samples or once per sampling event, whichever is more frequent.

TABLE G-3.1
FIELD QC SAMPLING REQUIREMENTS

QC Sample	Sample Matrix	Sample Location	Preparation Method	Laboratory Frequency
Equipment Rinsate Blank	Aqueous	Field	DI/DS water through sampling equipment and preserved.	Daily or one every 20 samples.
Field Blank	Aqueous	Field	DI/DS water not exposed to sampling equipment.	One per sampling event or one every 20 samples.
Field Duplicate	Aqueous and Solid	Field	Co-located samples collected identically and consecutively.	One per sampling event or one per 20 samples.
Trip Blanks	Aqueous (VOCs only)	Laboratory	DI/DS Water	One per sample shipment.

STANDARD OPERATING PROCEDURE G-4

SAMPLE CUSTODY

Standard Operating Procedure
Sample Custody (G-4)

A stringent, established program of sample chain-of-custody procedures shall be followed during field sample collection and handling activities to account for each sample. Preprinted labels will be used to maintain the highest degree of control in sample handling. The preprinted labels(with spaces provided) will ensure that all necessary information is retained with the sample chain-of-custody records, and shipping manifest will be utilized to maintain control over access to the sample destination after shipment from the sample collection site.

SAMPLE CONTROL FORMS

Sample Label

Each sample collected at the site shall be identified with a sample label. The following information shall be recorded on the label:

1. Project number,
2. Sample type (grab or composite, media sampled),
3. Sample identification (well number for groundwater samples, soil boring number, sample number, and sample depth for soil samples, etc.),
4. Date and time sample was taken,
5. Sampler's name,
6. Sample tag number (a unique serial number stamped or written on each sample label; duplicates and blanks shall be assigned separate sample numbers),
7. Preservative added, and
8. Remarks, including pertinent field observations.

Chain of Custody Record

Chain-of-custody records ensure that samples are traceable from the time of collection until introduced as evidence in legal proceedings. A sample is in a person's custody if any of the following criteria are met:

1. The sample is in the person's possession.
2. The sample is in the person's view after being in possession.
3. The sample has been locked up to prevent tampering after it was in the person's possession.
4. The sample was in the person's possession, then was transferred to a designated secure area.

The chain-of-custody record is completed in the field by the individual physically in charge of the sample collection. The chain-of-custody record may be completed concurrently with the field sample data sheet or before shipping samples to the laboratory. The sampler is personally responsible for the care and custody of the sample until it is shipped.

When transferring the sample possession, the individuals relinquishing and receiving the sample will sign, date, and write the time of day on the chain-of-custody record. The chain-of-custody record is enclosed with the sample after it has been signed by the sampler.

The chain-of-custody record also serves as the laboratory request form. As shown on the attached sample chain-of-custody form, a space is included on the form to list the analyses requested for each set of samples.

Field sample data is to be recorded in the field notebook. The field data correlates the assigned sample bottle designation to a specific well or sample location, or to other distinguishing features or attributes (i.e., dummy sample, duplicate sample, sample blank, etc.).

STANDARD OPERATING PROCEDURE G-5

SOIL AND WATER SAMPLING FIELD EQUIPMENT DECONTAMINATION

Standard Operating Procedure
Soil and Water Sampling Field Equipment Decontamination (G-5)

To prevent potential cross-contamination of samples, all reusable soil and water sampling equipment and pumps shall be decontaminated. The sample personnel shall set up the area used to decontaminate soil and water sampling equipment in the manner shown on Figure G-5-1. This area will be located upwind from the specific sampling area. The personnel performing the decontamination procedures will wear protective clothing as specified in the site-specific Health and Safety Plan.

PROCEDURES USED TO DECONTAMINATE INORGANICALLY CONTAMINATED SOIL SAMPLING EQUIPMENT

Table G-5.1 lists the equipment that shall be used to decontaminate the soil sampling equipment and the decontamination station where it will be used. The specific procedures for decontaminating inorganic contaminated soil sampling equipment include the following:

1. At Station No. 1, first wash the contaminated equipment in a tub containing tap water to remove the soil material. Follow with a second wash in a tub containing water mixed with a detergent, such as Alconox.
2. Move the equipment to the wash tub in Station No. 2. Rinse the equipment with clean water, wash with 0.1 Normal nitric acid (HNO_3), then rinse with distilled/deionized (DS/DI) water.
3. At Station No. 3, place the clean equipment on plastic sheeting until it is used again.

   After decontaminating all the soil sampling equipment, the disposable gloves and used plastic from Station No. 3 shall be placed in garbage bags and disposed in a trash collection facility. The wash and rise water from Station Nos. 1 and 2 will be disposed in accordance with the site-specific SAP. At the end of each day, all soil sampling equipment shall be stored in large plastic bags.

PROCEDURES USED TO DECONTAMINATE INORGANICALLY CONTAMINATED WATER SAMPLING EQUIPMENT

Table G-5.2 lists the equipment that shall be used to decontaminate the water sampling equipment and the decontamination stations where it will be used. (To decontaminate pumps, see section **Decontamination of Sampling Pumps** at the end of this SOP).

The specific procedures for decontaminating inorganic contaminated water sampling equipment include the following:

1. At Station No. 1, wash the contaminated equipment in a tub containing water mixed with a detergent such as Alconox.
2. Move the equipment to the wash tub in Station No. 2. First, rinse the equipment with DS/DI water. Then rinse the equipment with dilute (0.1 Normal) nitric acid and follow with a second rinse using DS/DI water.
3. At Station No.3, place the clean equipment on plastic sheeting until it is used again.

After decontaminating all the water sampling equipment, the disposable gloves and used plastic from Station No. 3 shall be placed in garbage bags and disposed in a trash collection facility. The wash and rinse water from Station No. 1 and No. 2 will be disposed in accordance with the site-specific SAP. At the end of each day, all water sampling equipment shall be stored in large plastic bags.

PROCEDURES USED TO DECONTAMINATE ORGANICALLY CONTAMINATED SOIL SAMPLING EQUIPMENT

Table G-5.3 lists the equipment and supplies that shall be used to decontaminate the soil sampling equipment and the decontamination station where it will be used. The specific procedures for decontaminating the organic contaminated soil sampling equipment include the following:

1. At Station No. 1, Tub No. 1, wash and scrub with a detergent such as Alconox, or use a pressurized steam cleaner to remove the soil material. Collect the waste water for disposal in accordance with the site-specific SAP.
2. At Station No. 1, Tub No. 2, double rinse the equipment with DS/DI water.
3. At Station No. 2, rinse the equipment with methanol followed by a double rinse with DS/DI water.
4. At Station No. 3, lay the equipment on the clean plastic to air dry.
5. Wrap the equipment in clean plastic until reuse.

The disposable gloves and used plastic from Station No. 3 shall be placed in garbage bags and disposed in the trash collection containers. The wash and rinse waters from Stations No. 1 and 2 will be disposed in accordance with the site-specific SAP.

PROCEDURES USED TO DECONTAMINATE ORGANICALLY CONTAMINATED WATER SAMPLING EQUIPMENT

Table G-5.4 lists the equipment and supplies that shall be used to decontaminate the water sampling equipment and the decontamination station where it will be used. (To decontaminate pumps, see section **Decontamination of Sampling Pumps** at the end of this SOP.)

The specific procedures for decontaminating the organic contaminated water sampling equipment include the following:

1. At Station No. 1, Tub No. 1, wash and scrub the equipment with a detergent such as Alconox, or use a pressurized steam cleaner to remove the soil material. Collect the waste water for disposal in accordance with the site-specific SAP.
2. At Station No. 1, Tub No. 2, double rinse the equipment with DS/DI water.
3. At Station No. 2, rinse the equipment with methanol followed by a double rinse with DS/DI water.
4. At Station No. 3, lay the equipment out on the clean plastic to air dry.
5. Wrap the equipment in the clean plastic until reuse.

The disposable gloves and used plastic from Station No. 3 shall be placed in garbage bags and disposed in the trash collection containers. The wash and rinse waters from Stations No. 1 and 2 will be disposed in accordance with the site-specific SAP.

DECONTAMINATION OF SAMPLING PUMPS

When using field decontamination, it is advisable to begin sampling with the well containing the lowest anticipated analyte concentration. Successive samples should be obtained from wells anticipated to have increasing analyte concentrations. Use of dedicated pump equipment is preferable when feasible. Table G-5.5 lists the decontamination equipment required.

When pumps (e.g., submersible or bladder) are submerged below the water surface to collect water samples, they should be cleaned and flushed between uses. This cleaning process consists of an external detergent wash and high-pressure tap water rinse, or steam cleaning, of pump casing, tubing and cables, followed by a flush of potable water through the pump. This flushing can be accomplished by pouring clean tap water from a carboy into the end of the discharge tube and working it down to the inside of the pump. The procedure should be repeated; then the tubing and inside of the pump should be rinsed with DS/DI water.

Surface pumps (e.g., peristaltic or diaphragm) used for well evacuation need not be cleaned between well locations. However, a new length of polyethylene tubing must be used for each well and discarded after use. The pump and hose should always be placed on clean polyethylene sheeting to avoid contact with the ground surface.

TABLE G-5.1

DECONTAMINATION EQUIPMENT FOR INORGANICALLY CONTAMINATED SOIL SAMPLING EQUIPMENT

Equipment List for Decontamination

Item	Quantity
3-gallon plastic tubs	3
5-gallon plastic container, tap water	a
5-gallon carboy, DS/DI water	a
Alconox	a
0.1 Normal Nitric Acid	a
Hard-bristle brushes	2
Plastic sheeting or garbage bags	a
Personal protective equipment	a,b
Kimwipes	a
55-gallon drum(s)	a
Drum labels	a
Spray paint	a

Equipment at Decontamination Stations

Station No. 1
- Alconox
- Tap water
- Two 3-gallon plastic washtubs
- Scrub brush
- DS/DI water

Station No. 2
- 3-gallon plastic washtub
- DS/DI water
- 0.1 Normal Nitric Acid

Station No. 3
- Plastic sheeting or garbage bag

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a Quantity depends on the size of the sampling effort and is, therefore, left to the discretion of the field hydrogeologist or geologist.

b Type of protective equipment as specified in the site-specific Health and Safety Plan.

TABLE G-5.2

DECONTAMINATION EQUIPMENT FOR INORGANICALLY CONTAMINATED WATER SAMPLING EQUIPMENT

Equipment List for Decontamination

Item	Quantity
3-gallon plastic tubs	3
5-gallon plastic container, tap water	a
5-gallon carboy, DS/DI water	a
Alconox	a
0.1 Normal Nitric Acid	a
Hard-bristle brushes	2
Plastic sheeting or garbage bags	a
Personal protective equipment	a,b
Kimwipes	a
55-gallon drum(s)	a
Drum labels	a
Spray paint	a

Equipment at Decontamination Stations

Station No. 1
- Alconox
- Tap water
- Two 3-gallon plastic washtubs
- Scrub brush
- DS/DI water

Station No. 2
- 3-gallon plastic washtub
- DS/DI water
- 0.1 Normal Nitric Acid

Station No. 3
- Plastic sheeting or garbage bag

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a Quantity depends on the size of the sampling effort and is, therefore, left to the discretion of the field hydrogeologist or geologist.

b Type of protective equipment as specified in the site-specific Health and Safety Plan.

TABLE G-5.3

DECONTAMINATION EQUIPMENT FOR ORGANICALLY CONTAMINATED SOIL SAMPLING EQUIPMENT

Equipment List for Decontamination

Item	Quantity
3-gallon plastic tubs	3
5-gallon plastic container, tap water	a
5-gallon carboy, DS/DI water	a
Alconox	a
Hard-bristle brushes	2
Methanol	a
Plastic sheeting or garbage bags	a
Personal protective equipment	a,b
Kimwipes	a
55-gallon drum(s)	a
Drum labels	a
Spray paint	a

Equipment at Decontamination Stations

Station No. 1
- Alconox
- Tap water
- Two 3-gallon plastic washtubs
- Scrub brush
- DS/DI water

Station No. 2
- 3-gallon plastic washtub
- Methanol and DS/DI water

Station No. 3
- Plastic sheeting or garbage bag

a Quantity depends on the size of the sampling effort and is, therefore, left to the discretion of the field hydrogeologist or geologist.

b Type of protective equipment as specified in the site-specific Health and Safety Plan.

TABLE G-5.4

DECONTAMINATION EQUIPMENT FOR ORGANICALLY CONTAMINATED WATER SAMPLING EQUIPMENT

Equipment List for Decontamination

Item	Quantity
3-gallon plastic tubs	3
5-gallon plastic container, tap water	a
5-gallon carboy, DS/DI water	a
Alconox	a
Hard-bristle brushes	2
Methanol	a
Plastic sheeting or garbage bags	a
Personal protective equipment	a,b
Kimwipes	a
55-gallon drum(s)	a
Drum labels	a
Spray paint	a

Equipment at Decontamination Stations

Station No. 1
- Alconox
- Tap water
- Two 3-gallon plastic washtubs
- Scrub brush
- Acetone and methylene chloride or hexane

Station No. 2
- 3-gallon plastic washtub
- Methanol and DS/DI water

Station No. 3
- Plastic sheeting or garbage bag

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a Quantity depends on the size of the sampling effort and is, therefore, left to the discretion of the field hydrogeologist or geologist.

b Type of protective equipment as specified in the site-specific Health and Safety Plan.

TABLE G-5.5

DECONTAMINATION EQUIPMENT FOR SAMPLING PUMPS
EQUIPMENT LIST FOR DECONTAMINATION OF SUBMERSIBLE PUMPS

Equipment List for Decontamination of Submersible Pumps

Item	Quantity
Alconox	a
Tap water	a
Hard-bristle brushes	1
Plastic sheeting or garbage bags	a
Personal protective equipment	a,b
30-gallon plastic trash can or plastic overpack drum	1
55-gallon drum(s)	a
Drum labels	a
Steam cleaner	Optional

Equipment List for Decontamination of Surface Pumps

Item	Quanity
Polyethylene tubing	a
Plastic sheeting or garbage bags	a

a Quantity depends on the size of the sampling effort and is, therefore, left to the discretion of the field hydrogeologist or geologist.

b Type of protective equipment as specified in the site-specific Health and Safety Plan.

STANDARD OPERATING PROCEDURE GW-1

GROUND WATER SAMPLING FOR ORGANICS

STANDARD OPERATING PROCEDURE
GROUND WATER SAMPLING FOR ORGANICS

ORGANIC ANALYSES

1. Remove well cap and screen headspace for organic vapors using the appropriate field monitoring instrument (e.g., HNU photoionization detector, organic vapor analyzer (OVA)). Refer to the site-specific Health and Safety Plan for detailed information on screening the well headspace, if organic vapors are expected.

2. Check for floating product, if suspected, using a translucent-bottom sampling bailer. If floating product is present, measure floating product level and water level using an interface probe or bailer. Measure the well depth and calculate the casing storage volume and floating product volume (if present).

3. Purge a minimum of three casing volumes using a submersible pump or bailer. Purging should be performed from the top of the water column to ensure that all stagnant water is removed from the well. The pump should be moved periodically down into the water column as the drawdown increases, with the distance between the water level and the pump kept at a minimum. Field measurements for pH, conductivity, and temperature should be made at 1,2, and 3 casing volumes to ensure that all stagnant water has been removed from the well and the water quality parameters have stabilized. The water quality parameters are stabilized when the pH values are within 0.1 pH, and the temperature and conductivity values are within 10% over one casing volume. Dispose of purge water in accordance with procedures provided in the site-specific SAP.

4. Collect samples after well has recharged sufficiently to collect samples. Samples should be collected using a stainless steel, Teflon, or acrylic bailer and observe contents for evidence of free floating product. The sample should be transferred directly from the bailer to appropriate sample containers with minimal agitation of water to prevent volatilization of organics. If free floating product is obtained, collect a sample for subsequent analysis.

5. Collect all samples in duplicate. Fill sample bottles to overflowing. No air bubbles should pass through the sample as the bottle is filled or be trapped in the sample when the bottle is sealed. A positive meniscus at the top of the bottle will help ensure that no air is trapped inside when cap is screwed down on the bottle.

6. When sampling wells with a bailer, the volatile organic compound sample should be collected from the first bailer following well purging. Precautions must be taken to prevent aeration of the sample.

STANDARD OPERATING PROCEDURE GW-3

MONITORING WELL DESIGN AND CONSTRUCTION

Standard Operating Procedure
Monitoring Well Design and Construction (GW-3)

A universal, set procedure for designing and constructing monitoring wells cannot be listed. Every location within a site may vary depending on contamination encountered, lithology of the subsurface and depth to ground water. A technique that may work at one location may be inappropriate at the next. The following section discusses general guidelines for well design and construction, but actual well designs will depend on site conditions and should be addressed in site-specific SAP and SOP.

Wells drilled for an RI/FS investigation will be designed to specifications suggested by the site being investigated, provided such design presents no conflict with investigation sampling objectives. The policy will permit the site to incorporate any new wells resulting from RI activities into ongoing monitoring programs by ensuring that new wells are constructed in the same manner as existing wells. Conflicts may result when existing well construction is not suitable for the proposed sampling.

The method of well construction and the materials used in the casing and screen may affect the quality of the well, and its utility for ground water monitoring, throughout its lifetime. The elements of proper monitoring well construction presented in this SOP serve as guidelines for wells constructed for the ground water investigation. In addition, these guidelines can be applied to evaluate the adequacy of existing wells when RI sampling will be conducted from available wells. Typical well completion details are shown on Figure GW-3.1.

Well Diameter

The diameter of the well casing will be the minimum that allows the sampling tool to be lowered to the desired depth. The diameter of the borehole, in unconsolidated formations, into which the casing is placed must be at least 4 inches larger than the casing to provide a minimum 2 inches of annular space for placement of sand pack and seal. The diameter of the borehole in consolidated formations shall also be a minimum of 4 inches larger than the casing if installation of the seal is expected.

Well Depth

Wells shall be constructed to be depth discrete, with the well screened in only one aquifer, zone, or layer. This allows the sampling of the area of interest without interference from other layers. This requires provisions for grouting above, and if necessary, below the well screen on the outside of the casing.

Well Casing/Screens

Well casings and screens will be constructed of materials with the least potential for affecting the quality parameters of the sample. Guidance regarding casing and screen materials selection criteria is presented in Table GW-3.1. Well casing and screen shall be steam cleaned and protected from contamination prior to their installation.

Well Drilling

Drilling method selection shall be based on minimizing both the disturbance of the geologic materials penetrated, and the introduction of air, fluids and muds. Organic drilling muds or additives shall be avoided. Advantages and disadvantages of various drilling methods are presented in Table GW-3.2.

Screen Zone Design

The screen zone of the monitor well shall be designed and constructed to: (1) allow sufficient ground water flow to the well for sampling; (2) minimize the passage of formation materials into the well; and (3) ensure sufficient structural integrity to prevent the collapse of the screen structure.

For wells completed in unconsolidated materials, the intake of a monitoring well should consist of a screen or slotted casing with openings sized to ensure that formational material is prohibited from passing through the well during development. The annular space between the face of the formation and the screen or slotted casing should be filled to minimize passage of formation materials into the well. The driller should, therefore, install a sand pack in each monitoring well. It is recommended that aquifer material from the screen zone be analyzed fro grain size in order to determine the correct sand pack and screen slot size.

Screen Size Selection

The screen slot size is determined after the filter pack material has been selected. The screen slot size for a well with a designed filter pack should be selected to retain 90 percent or more of the filter pack material. See the references at the end of the SOP for further detail.

Selecting the Filter Pack

The purpose of selecting the proper filter pack is to 1) stabilize the aquifer material around the well, 2) provide an annular zone with high permeability, and 3) permit the use of the largest possible size of screen openings.

The selection of the filter pack is a vital step in completing a usable well. The design and selection of a proper filter pack is an issue which has many factors to be considered and which cannot be given satisfactory explanation in this SOP. A person designing a well should select and read one of the excellent reference books available on the subject. See the reference list at the end of this SOP.

The following information gives the general guidelines used in selecting the well filter pack. For a detailed explanation of the filter pack selection, refer to the references provided at the end of this SOP.

1. Perform a sieve analysis on the natural aquifer material.
2. Select a filTer pack whose grain size is 4 to 10 times larger than the 30 percent of the finer natural aquifer material.
3. The filter pack grain size should have a uniformity coefficient around 2.5.
4. The filter pack material shall be a siliceous material such as quartz sand, have well-rounded grains, and contain less than 5 percent not-siliceous material.

Placement of the Filter Pack Material

The selected filter pack will be introduced into the annular space adjacent to the screen through a tremie pipe. A minimum 1 1/2-inch diameter tremie pipe is suggested. The end of the tremie pipe should be positioned within 5 feet of the bottom of the borehole before treming in the filter material. As the filter material is tremied into the annular space, the tremie pipe should be raised periodically but kept within 5 feet of the top of the filter pack. This 5-foot interval minimizes bridging and segregation of the filter pack as it is placed. The filter pack placement will continue until the filter pack is 3 feet above the top of the screen.

The top of the sand pack should be measured periodically and recorded in the bound logbook. The total volume of filter material used should also be recorded.

Annular Seal

The materials used to seal the annular space must prevent the migration of contaminants to the sampling zone from the surface to intermediate zones and prevent cross contamination between strata. The materials should be chemically compatible with the anticipated waste to ensure seal integrity during the life of the monitoring well and chemically inert so they do not affect the quality of the ground water samples. The permeability of the sealants should be one to two orders of magnitude less than the surrounding formation. An example of an appropriate use of annular sealant material is using a minimum of two feet of certified sodium bentonite pellets immediately over the silica sand when in a saturated zone. The pellets are most appropriate in a saturated zone because they will swell in the column of water to create an effective seal. A cement and bentonite mixture or antishrink cement mixtures should be used as the annular sealant in the unsaturated zone above the bentonite pellet seal and below the frost line.

Cement-bentonite grout shall also be used to seal the annular space between the casing and borehole wall and between the surface formation and the conductor casing, if such is used. At the surface, the grout shall have positive slope away from the well or piezometer to prevent water from ponding and entering around the casing.

The grout shall be composed of Class B or G Portland cement, fresh water, and 2 to 4 percent bentonite. The grout shall be mixed in the following proportions: 6.5 gallons of water, 94 pounds (1 sack) of cement, and 2 percent (1.88 pounds, dry weight) of bentonite, or 7.8 gallons of water, 94 pounds (1 sack) of cement, and 4 percent (3.76 pounds, dry weight) of bentonite. The bentonite will improve the workability of the grout and reduce shrinkage as the cement sets.

Emplacement of the grout shall be by tremie pipe via gravity feed or pumping. The end of tremie pipe shall be set 5 feet above bottom of filled interval.

After installation of the cement slurry, a minimum of 24 hours of curing time shall elapse prior to resuming any construction operations at the particular borehole.

Well Head Installation

Wells may be constructed in either a "stick-up" or "flush-grade" completion. For a stick-up completion, the well or piezometer casing shall extend approximately 3 feet above ground surface. A vented casing cap with marked well or piezometer designation shall be placed on top of the surface casing. A steel protection casing shall be welded to the conductor casing and shall extend to at least 2 inches above the top of the casing cap. The protective casing shall be fitted with a locking cap and also marked with the well or piezometer designation. A concrete apron, extending at least 1 foot away from the casing and sloping away from the well, shall be constructed around the base of the protective casing. In high-traffic areas, four bumper guards shall be installed around the well. The bumper guards shall be brightly painted posts of 3-inch steel pipe filled with concrete and set in the concrete apron.

For a flush-grade completion, the top of the well or piezometer casing shall terminate at approximately four to six inches below ground surface. A vented casing cap with marked well designation shall be placed on top of the surface casing. A locking, protective steel monument shall be placed above the well casing. The top of the monument shall extend one to two inches above ground surface and the monument shall be cemented in place. A cement apron, extending at least six inches from the monument, and sloping away from the monument, shall be constructed around the monument.

Documentation of Well Design and Construction

Information on well design and completion will be documented when drilling and constructing the well, and will include, but not be limited to:

1. Date/time of construction.
2. Weather conditions.
3. Drilling method and drilling fluid used.
4. Sketch of well location.
5. Borehole diameter and well casing diameter.
6. Well depth (± 0.1 foot).
7. Drilling and lithologic logs.
8. Casing materials.
9. Screen materials and design.
10. Casing and screen joint type.
11. Screen slot size/length.
12. Filter pack material/size, grain analysis.
13. Filter pack volume calculations.
14. Filter pack placement method.
15. Sealant materials (percent bentonite).
16. Sealant placement method.
17. Date/time began grouting well.
18. Date/time of well completion.
19. Surface seal design/construction.
20. Well development procedure.
21. Type of protective well casing.
22. Ground surface elevation (0.01 ft).
23. Top of monitoring well casing elevation (0.01 ft).
24. Detailed drawing of well (include dimensions).

References:

F.G. Driscoll, Groundwater and Wells, Second Edition, St. Paul, Minnesota, Johnson Filtration Systems, Inc., 1986.

U.S. Department of the Interior, Ground Water Manual, Water Resources Technical Publication, 1977.

U.S. Environmental Protection Agency, Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Wells, National Water Well Association, 1989.

TABLE GW-3.1
WELL CASING AND SCREEN MATERIALS

Type	Advantages	Disadvantages
Polyvinyl chloride (PVC)	Excellent chemical resistance to weak alkalies, alcohols, aliphatic hydrocarbons and oils.	May absorb some constituents from ground water.
	Good chemical resistance to strong mineral acids, concentrated oxidizing acids and strong alkalies.	May react with and leach some constituents into ground water.
Polypropylene	Excellent chemical resistance to mineral acids.	May react with and leach some constituents into ground water.
	Good to excellent chemical resistance to alkalies, alcohols, ketones and esters.	May react with strong oxidizing acids.
	Good chemical resistance to oils.	
	Fair chemical resistance to concentrated oxidizing acids, aliphatic hydrocarbons, and aromatic hydrocarbons.	
Teflon (Teflon is a registered trademark of DuPont, Inc.)	Outstanding resistance to chemical attack; insoluble in all organics except a few exotic fluorinated solvents.	High cost relative to other materials.
Carbon steel	Strong and rigid, temperature sensitivity not a problem.	May react with and leach some constituents into ground water.
		Not as chemically resistant as stainless steel.
Stainless steel	Excellent resistance to corrosion and oxidation.	Heavier than plastics.
		May corrode and leach some chromium in very acidic waters.
		May act as a catalyst in some organic reactions.

TABLE GW-3.2
DRILLING METHODS FOR MONITORING WELLS

Type	Advantages	Disadvantage
Hollow stem auger	No drilling fluid is used, minimizing contamination problems. Formation waters can be sampled during drilling by using a screened lead auger or advancing a well point ahead of the augers. Hole caving can be overcome by emplacing screen and casing before augers are removed.	Can be used only in unconsolidated materials. Limited to depths of 100 to 150 feet, formation samples may not be completely accurate, depending upon how they are taken.
Mud rotary	Can be used in both unconsolidated and consolidated formations. Core samples can be collected. Capable of drilling to any depth. Casing not required during drilling. Flexibility in well construction.	Drilling fluid is required •Contaminants are circulated with the fluid. •The fluid mixed with the formation, water invades the formation, and is sometimes difficult to remove •Bentonite fluids may absorb metals and may interfere with some other parameters •Organic fluids may interfere with bacterial analyses and/or organic-related parameters No information on location of the water table and only limited information on water producing zones, is directly available during drilling. Formation samples may not be accurate.
Air rotary	No drilling fluid is used, minimizing contamination problems. Can be used in both unconsolidated and consolidated formations. Capable of drilling to any depth. Formation sapling ranges from excellent in hard, dry formations to nothing when circulation is lost in formations with cavities. Formation water is blown out of the hole along with cuttings making it possible to determine when the first water-bearing zone is encountered. Collection and field analysis of water blown from the hole can provide enough information regarding changes in water quality for parameters such as chlorides for which only large concentration changes are significant .	Casing is required to keep the hole open when drilling in soft, caving formations below the water table. When more than one water-bearing zone is encountered and hydrostatic pressures are different, flow and possible cross-contamination can occur from one water-bearing zone to another between the time drilling is completed and the hole can be properly cased and grouted off.
Cable tool	Only small amounts for drilling fluid (generally water with no additives) are required. Can be used in both unconsolidated and consolidated formation; well suited when caving, large gravel type formations with large cavities above the water table are encountered. Formation samples can be excellent with a skilled driller. When water is encountered, changes in potentiometric levels are observable. Relative permeabilities and rough water quality data from different zones penetrated can be obtained by skilled operators. Good seal between casing and formation if flush jointed casing is used.	Potential contamination by drilling fluid. Relatively large diameters are required (minimum 4-inch casing). Steel drive pipe must be used.

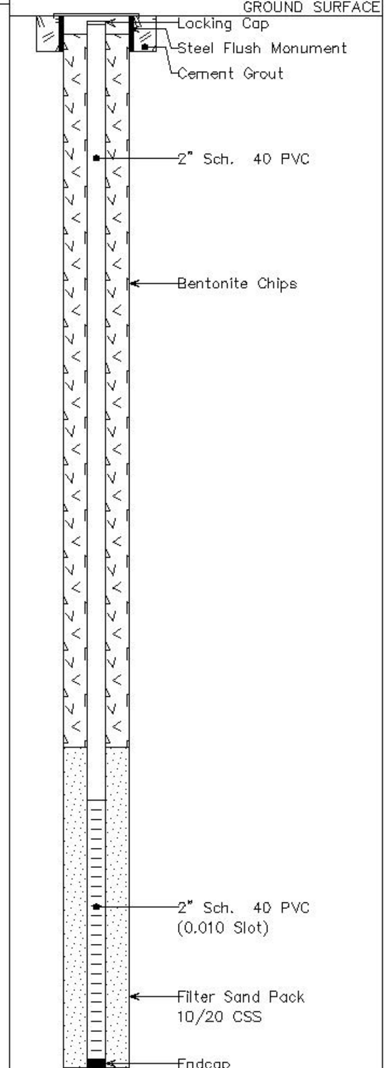
FIGURE GW-3.1
SCHEMATIC OF TYPICAL MONITOR WELL DESIGN

WELL NUMBER: MW2

PROJECT:	WELL LOCATION	DATE:	LOGGED BY:
OWNER NAME:	COUNTY:	HOLE DIA.: 8 in.	DRILL RIG:
ADDRESS:	SECTION:	TOC ELEV.: ft.	SAMPLER TYPE:
	TNSHP/RNG:	GROUND ELEV.: ft.	GW DEPTH: ft.

DESCRIPTION	GRAPHIC LOG	DEPTH (ft.)	SAMPLE RANGE	Headspace OVA	GW DEPTH (ft.)
Black cinder ash.		0		7	
Brown, silty sand and gravel with minor clay from 2 to 2.5 feet. Then sand and gravel.		10, 20, 30		6, 6, 6, 6, 6, 9, 6, 8, 8, 9, 12, 4, 34, 18	
Fine to coarse grained sand.		40		7, 11	
Interbedded silt and sand.				7	
No recovery.		50		5	▼
Total boring depth at 60'.		60			

WELL CONSTRUCTION DETAIL



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STANDARD OPERATING PROCEDURE GW-4

WELL DEVELOPMENT

Standard Operating Procedure
Well Development (GW-4)

The monitoring wells, pumping wells, and piezometers shall be developed after construction is completed. The purpose of the development is to remove any remnants of drilling fluid and fine-grained material and to restore the natural permeability of the screened formation. At a minimum, the following development techniques shall be available to develop the wells.

1. Surging with plunger
2. High velocity jetting
3. Airlift pumping
4. Overpumping and backwashing with submersible pump
5. Bailing

The development methods will be selected in the field by the supervising hydrogeologist. This decision will be based primarily on the condition of each well after construction. A description of the methods is provided below.

The duration of the development process will be determined by the supervising hydrogeologist. The amount of turbidity in the discharge water will be used as a guide to determine that development is complete. In addition to turbidity, physical parameters including temperature, pH, and specific conductivity will be measured. Use of the field test equipment will be found in SOP H-3 for conductivity, SOP H-1 for temperature and SOP H-2 for pH. These parameters should be stabilized or changing by less than 10 percent between readings at the end of development. Visual observation may be used to determine that the discharge water is clear. Water produced during development will be discharged in accordance with the site-specific SAP. Personnel will wear protective clothing and use equipment specified in the site-specific Health and Safety Plan.

All procedures used and measurements taken during development will be recorded in the field logbook. This information will include time required, volume of water removed, turbidity readings, pumping rate, and observations made during the development process.

All development equipment must be decontaminated in accordance with SOP G-5.

SURGING WITH PLUNGER

The surging shall be done by solid surge plunger. The belting discs shall be cut to form a free fit in the casing.

Before starting to surge, water should be bailed or pumped from the well to make sure that some water will flow into the well. For operation, the surge plunger shall be lowered into the casing about 15 feet below the water level. The plunger shall be operated up and down in the well casing to exert equal or approximately equal force on the inward and outward movement of the water through the screen. A surge plunger should not be run in a plugged well. In no case shall the surge plunger be operated below the top of the screen. The surging shall be started slowly at first and the speed increased as the work progresses until it reaches the fastest limit at which the tools will drop and rise without excessive slap of the cable. Periodically, the plunger will be removed and the amount of fines accumulated at the bottom of the well will be measured using a weighted steel tape. If fines have been drawn into the well and have blocked 10 percent or more of the total screen length, the well shall be bailed or otherwise cleaned to the bottom between the surge plunger runs. The bottom of the well should be cleaned by bailer or air lift after surge development is completed.

HIGH-VELOCITY JETTING

This method should be used at the beginning of well development, so that any water introduced into the formation during jetting would be removed during later stages of the development. Development of the well shall be accomplished by high-velocity horizontal jetting with potable water of known chemistry. The jetting shall proceed from the bottom of the screen to the top. The outside diameter of the jetting tool shall be one inch less in diameter than the screen inside diameter. The maximum exit velocity of the jetting water at the jet nozzle shall be 150 feet per second. The jetting tool shall be rotated at a speed of less than one revolution per minute. It shall be positioned at one level for not less than two minutes and then shall be moved to the next level, moving more than 6 inches upward from the preceding jetting level.

AIR LIFT PUMPING

Development of the well shall be conducted by utilizing an air line and an air and water eductor pipe. The air line will be placed inside the eductor pipe with the end of the line near, but not extending below, the end of the pipe. Discharge of air from the air line shall always occur within the eductor pipe to prevent clogging of the filter pack and/or formation with air bubbles. Air lift development procedures should begin by determining that ground water can flow freely into the screen. Application of too much air volume in the well when the formation is clogged can result in a collapsed screen. To minimize the initial pumping rate, the air line and eductor pipe should be placed at shallow submergence. Once uninhibited flow to the screen has been established, the air line and eductor pipe should be lowered to approximately 5 feet above the bottom of the screen. Air will then be pumped through the air line causing displacement of the water in the eductor pipe and flow of water into the well. Development will continue by raising the air line/eductor pipe at approximately 5-foot intervals until the entire screen length has been pumped.

For the piezometers, which are not foreseen for sampling ground water, an alternate method of air lift may be used because of the small casing diameter. This method uses only an air line, and the well casing acts as the eductor pipe. The air line shall be placed at least 5 feet above the screen, or at the bottom of the well within the sump. At no time during development should the air line be moved within the screen area. Maintaining the air line above or below the screen prevents charging the filter pack and/or formation with air, which can cause clogging.

The compressors, air lines, hoses, fittings, etc. shall be of adequate size to pump the well by the air lift method. Pressurized air from air compressor(s) needs to be specifically filtered so that oil from the compressor does not contaminate the well.

Air lift pumping development produces best results when the submergence ratio of the air line is about 60 percent for wells 200 feet or less in depth (Ground Water and Wells, Johnson, 1972). The percent pumping submergence can be calculated as follows:

$$\textit{percent pumping submergence} = \frac{\textit{length of airline below pumping water level}}{\textit{total length of well airline}} \times 100$$

The desirable drawdown is from static water level to the top of screen. The pumping rate will be estimated from available drawdown and pumping submergences.

OVERPUMPING AND BACKWASHING WITH SUBMERSIBLE PUMP

The pumping shall be done with a submersible pump capable of pumping at rates up to two times the estimated well capacity (well yield per unit drawdown). The pumping should be carried out in at least five steps including pumping rates of 0.25, 0.5, 1, 1.5, and 2 times the estimated well capacity. Pumping shall be conducted in five-minute cycles and shall continue until acceptable standards as explained at the beginning of SOP are attained.

BAILING

Where the nature of the formation and/or well construction make development of the well infeasible using pumps or air lift, bailers shall be utilized to evacuate water and fine sediments and/or fine formation particles from the well. Bailers should be of diameter allowing free-fall inside the well casing and should be equipped with a check valve at the bottom. The frequency of bailing trips shall depend on the ability of the well to recover.

STANDARD OPERATING PROCEDURE GW-5

MEASUREMENT OF WATER ELEVATION, FLOATING PRODUCT THICKNESS AND DETERMINATION OF WELL CASING VOLUME

Standard Operating Procedure
Measurement of Water Elevation, Floating Product Thickness and Determination of Well Casing Volume (GW-5)

This SOP includes the procedures for measuring water levels and calculating the water elevation, measuring the thickness of a floating product layer in a well, and the formulas for determining the well casing volume.

The water level and floating product thickness measurements, and the water level elevation and casing calculations shall be recorded in the bound field logbook in accordance with SOP G-4. Entries in the logbook shall include, but are not limited to:

1. Date and time the water level measurement is taken,
2. Name/initials of the individual(s) accomplishing the task,
3. The well/piezometer identification number of designation,
4. The elevation of the top of the casing MP,
5. The serial number or other identification number of the water level measuring device being used,
6. Water level measuring device calibration data and date,
7. The depth-to-water measurement from the MP, and
8. The calculated elevation of the water level.

WATER LEVEL MEASUREMENT

Depth to water level will be measured using an electric water-level measuring device. A light on the water level measuring device illuminates when the weighted probe tip contacts the water surface in the well and completes and electronic circuit. The measured depth to water is determined by noting the point on the probe cable which corresponds to the measuring point (MP) at the top of the well/piezometer casing at the initial point of contact. Detailed procedures for using the water level device and for taking the water level measurements are provided in the "Field Procedures" section below.

Field Procedures

The sampling crew will wear protective clothing and use the equipment (or comparable equipment) specified in the site-specific Health and Safety Plan.

1. Check the operation of the meter by turning on the indicator signal switch and pressing the test button on the side of the reel. The buzzer should sound and, if present, the indicator light should illuminate. If the water-level indicator signal(s) is not functioning properly, check the batteries and/or use a different meter.

2. Decontaminate the probe and graduated cable with distilled water. The cable should be decontaminated only if the bottom of the well or piezometer will be sounded. The length of cable to be decontaminated is determined by the distance between the water level and bottom of the casing. The bottom of the casing can be estimated from the completion log.

3. Holding the device atop the casing, lower the cable gradually into well or piezometer until the indicator contacts the water surface. The contact with water surface is indicated by a buzzer sound and illumination of the indicator light. Stop lowering the cable.

4. Note the point on the graduated cable that corresponds to the MP at the top of the casing when the electronic circuit is first completed. If the cable is not graduated to tenths of feet, use an engineer's rule and measure from the point on the cable which corresponds to the MP, down to the first incremental marker. Add this measurement to the marker measurement for the depth to water reading.

5. Record the value read from the cable as the depth to water surface to the nearest 0.01 foot.

6. Draw the cable about halfway up the casing, then lower it and repeat Steps 2 through 4. If these readings differ by more than 0.02 foot, repeat until the measured readings stabilize.

7. Remove the cable from the well or piezometer.

8. To locate the bottom of the well or piezometer, lower the weighted measuring tape or cable slowly from the center of the casing. When probe is felt to hit the bottom, or the cable slacks noticeably, draw the cable up very slowly until it is taut again.

9. Note the cable reading at the MP. Record this value as the well depth to the nearest 0.1 foot.

10. Repeat Steps 8 through 10.

Maintenance

1. Carry spare batteries for the water-level measuring device at all times. Check the operation in the field laboratory prior to use by dipping the probe into a beaker of clean water (do not use deionized water). If the indicator does not function properly when tested, the device shall either be repaired and retested prior to further use, or the device shall be returned to the manufacturer for repairs and another measuring device substituted.

2. Clean the cable at the end of each day of sampling by rinsing with tap water and wiping dry with paper towels. In addition, clean the cable between measurements any time solids adhere to it.

Calculations

Absolute water level elevation = elevation of MP (surveyed) - measured depth to water from the MP

MEASUREMENT OF FLOATING PRODUCT

If floating product is present, measure floating product level and water level using a translucent bailer or an Interface Probe, ORS Environmental Equipment Model No. 1068013 or 1068017, or equivalent. The probe contains two different sensor units, one for detecting the liquid/air interface, and one for distinguishing between water and hydrocarbon. To determine if the liquid is conductive (water), or nonconductive (hydrocarbon), a small intrinsically safe electrical current is passed between two electrodes on the sensor. Current flow will occur only in conductive fluids such as water.

Field Procedures for Bailer

1. Use only a new, disposable bailer or a bailer decontaminated in accordance with SOP G-5.

2. Slowly lower the bailer into the well until the bailer reaches the top of the liquid level in the well. Continue to lower the bailer into the liquid a distance of 90% of the bailer length. For a three foot bailer, lower it no further than 2.7 feet into the liquid.

3. Remove the bailer from the well and measure the thickness of floating product in the bailer to the nearest 0.01 feet.

Field Procedures for Interface Probe

1. Attach grounding clip to a confirmed or suitable earth ground before lowering the probe.

2. To turn the unit on, unfold the crank handle away from the reel housing. This activates a power switch inside the reel.

3. To verify that the unit is operational, press the test button on the face plate. If the power is ON, the audible alarm will sound. A low battery condition will cause the low battery indicator to be illuminated.

4. To release the probe, pull the protector tube outward from the reel casing. To lower the probe, tilt the front of the reel housing forward and press the brake release. The brake release is located just forward of the handle. The tape will reel out as long as the brake release is depressed.

5. When the probe contacts liquid, an alarm in the reel will sound. A beeping tone indicates water, a solid tone indicates hydrocarbon. To determine the exact thickness of a hydrocarbon layer, the probe should be moved slowly up and down so that the alarm alternates between OFF and ON (a solid tone). With the probe at the exact point where the alarm begins to sound, read the numbers on the tape to determine the distance from the MP at the top of the well to the air/oil interface. Next, lower the probe until the alarm tone begins to beep. The probe should be moved up and down until the exact point where the alarm tone changes from solid to become beeping is found. The thickness of the hydrocarbon layer is determined by subtracting the first reading from the second reading.

6. After taking a measurement, snap the protector tube shut so that the wiper rests against the tape. Release the brake and slowly reel in the tape until the probe is just below the

wiper. Do not allow the probe to bottom out against the wiper, as this will apply stress to the tape. Next, open the protector tube and gently reel the probe two-thirds of the way into the tube. Forcibly reeling the probe all the way into the tube may stress or break the measuring tape. Now, turn the entire interface probe assembly upside down so that the probe falls the rest of the way into the protector tube. Make sure that the probe is entirely within the protector tube. Finally, close the protector tube.

Maintenance

1. After every measurement, the probe should be washed in Alconox detergent, rinsed in distilled water, washed again in Alconox and rinsed for a final time in distilled water.

2. Clean all accessible parts of the reel assembly.

3. Periodically replace the batteries. Batteries must be changed only in a non-hazardous location.

Calculations

1. Thickness of hydrocarbon layer. See number 5 under Field Procedure (above).
2. Absolute water table elevation. See Calculations section on page GW-5.2.
3. Volume of water (V) contained in casing. See calculations below.

DETERMINATION OF WELL CASING VOLUME

The following equations are used to calculate <u>one casing volume</u>. Equation 1 gives the volume (V_1) in <u>cubic feet</u>, and equation 2 give the volume (V_2) in <u>gallons</u>.

1. $V_1 = 0.0055 * (d*d) * W$ 2. $V_2 = 0.0408 * (d*d) * W$

Where:
d = the well casing diameter in inches; and
W = the depth of water in the well casing measured, in feet, is calculated by subtracting the measured depth to water in the well from the total depth. The total well depth can be obtained from the well installation/completion details, or by manually measuring the well's total depth.

Example

Monitoring well radius = 4-inch diameter
Water level = 25.5 feet (below ground surface)
Well bottom = 36.0 feet (below ground surface)

Therefore, the well has <u>10.5 feet</u> of water.

Using equation 3: $V_3 = 0.017\ (4''*4'')\ 10.5'$

$V_3 = 2.86$ cubic feet

Or using equation 4: V_4 = 0.13 (4"*4") 10.5'

V_4 = 21.8 gallons

Therefor, 2.86 cubic feet or 21.8 gallons would be the <u>minimum three well casing volumes</u> that need to be purged from this well.

STANDARD OPERATING PROCEDURE SS-1

SAMPLE COLLECTION FROM SOIL BORINGS, EXCAVATIONS AND HAND-DUG PITS

STANDARD OPERATING PROCEDURE SS-1
SAMPLE COLLECTION FROM SOIL BORINGS, EXCAVATIONS, AND HAND DUG PITS

SOIL BORING PROCEDURES

The following procedures are designed to be used during the operation of auger type drill rigs during soil sampling operations. The procedures listed below may be modified in the field by the agreement of the lead site sampler and drill operators based on field and site conditions after appropriate annotations have been made in the appropriate bound field logbook. **Prior to any subsurface work, have utilities (gas and electric, telephone, sewer, etc.) located by a regional one-call service or the utility companies as needed.**

1. Locate the site as directed in the site-specific Sampling and Analysis Plan (SAP).

2. Drillers prepare rig for operation. This includes; but is not limited to, decontamination of the drill rig tools and sampling equipment, leveling the rig, preparing the downhole tool, preparing the auger "flights", and establishing the drill over the location.

3. Mount the split tube to the drive stem.

4. Prior to using the split spoon sampler, sample the surface increment to a depth in accordance with the site-specific SAP.

5. Place split spoon sampler on the ground surface and advance sampler to the desired depth using the rig hammer.

6. After driving the split spoon sampler its entire length or upon refusal of advancement, recover the split spoon sampler. Refusal is defined as 100 blows with the rig hammer and less than 6 inches advancement of the split spoon sampler. Less than 100 blows may be defined as refusal if there is no split spoon advancement. This decision will be made at the discretion of the field sampler.

7. After recovery of the split spoon sampler, open the spoon and place the spoon containing the soil sample into a holding device, maintaining the intervals as sampled.

8. Sampling personnel will then describe the soil sample based on the site-specific SAP instructions, and fill out the appropriate bound file logbooks, field profile sheets, field site sheets, and quality assurance/quality control documentation.

9. Decontaminate the split spoon sampler.

10. Repeat steps 3 to 9 until sampling is completed.

11. The drill rig tools and sampling equipment will be decontaminated prior to moving onto the next site. The drill rig will be left in a safe and secure fashion at the end of each shift.

BACKHOE PIT EXCAVATIONS

The following procedures are designed to be used during the operation of backhoe equipment to excavate sites prior to soil sampling operations. The procedures listed below may be modified in the field by the agreement of the lead site sampler and backhoe operators based on field and site conditions after appropriate annotations have been made in the appropriate bound field logbook.

1. Locate the site as directed in the site-specific SAP. Identify locations of underground utilities.

2. Place the backhoe tractor in a safe position. This will be based on the operators judgment and site conditions.

3. Begin backhoe excavation. Place excavated materials a sufficient distance from the excavation to prevent the return of excavated materials to the pit. Topsoil will be determined by the technical field support, removed, and segregated from the underlying soils.

4. Continue excavation of the pit to the required depth. This depth shall not exceed 5 feet from the ground surface unless the proper pit exit trenches, shoring, and sloping excavations have been excavated to prevent accidental burials of sampling crew and to meet or exceed all OSHA Construction Standards (29 CFR 1926; Appendix A) for entrance by sampling personnel. If OSHA Construction standards for entrance cannot be met, the sample will be obtained from the backhoe bucket.

5. Sampling personnel may enter the pit after all excavation is complete and the excavation is deemed safe to occupy. The site safety officer shall be the oversight authority and will determine what is safe and what is not safe. "Safe" for backhoe pit excavations is defined as meeting or exceeding all OSHA Construction Standards (29 CFR 1926; Appendix A), for entrance by sampling personnel.

6. Soil profile descriptions shall be made from a hand cleaned surface along the pit wall using the Unified Soil Classification System.

7. Soil sampling will follow soil profile description and establishment of sampling intervals based on the site-specific SAP. Soil samples will be collected with decontaminated stainless steel or plastic sampling tools and bowls from the appropriate intervals. A sample collected from a depth increment shall be a representative composite of the entire interval and not biased by sample mass collected largely from the top or bottom of the increment.

8. All pertinent field quality assurance/quality control documentation, bound field logbooks, sample labels, profile sheets, and field site sheets shall be completed prior to refilling the pit.

9. After items 1 through 8 have been completed to the satisfaction of the lead sampler, the site pit shall be refilled with the previously excavated materials. The earthen materials are to be replaced in the same order they were excavated with topsoil placed on top of the filled pit. There will be some unavoidable mixing of soil during the excavation.

10. Decontaminate all sampling equipment, including the backhoe bucket.

11. Move to the next site. If the previous site was the last site of the day, decontaminate the backhoe bucket, secure, and park the backhoe tractor rig for the evening.

HAND DUG PITS

The following procedures are designed to be used during the operation of hand tools to excavate sites prior to soil sampling operations. The procedures listed below may be modified in the field by the agreement of the lead site sampler and field personnel based on field and site conditions after appropriate annotations have been made in the appropriate bound field logbook.

1. Locate the site as directed in the site-specific SAP.

2. Select the appropriate orientation for the excavation. This is be based on the lead field sampler's judgment and site conditions.

3. Begin pit excavation. Place excavated materials a sufficient distance from the excavation to prevent the return of excavated materials to the pit. Topsoil is to be placed separately from the underlying soils. Placement of excavated materials on a sheet of plastic is recommended to facilitate returning excavated material to the pit.

4. Continue excavation of the pit to the required depth. This depth shall not exceed 24 inches from the ground surface.

5. Soil profile descriptions shall be made from a hand cleaned surface along the pit wall using the Unified Soil Classification System.

6. Soil sampling will follow soil profile description and establishment of sampling intervals based on the site-specific SAP. Soil samples will be collected with decontaminated stainless steel or plastic sampling tools and bowls from the appropriate intervals. A sample collected from a depth increment shall be representative composite of the entire interval and not biased by sample mass collected largely from the top or bottom of the increment.

7. All pertinent field quality assurance/quality control documentation, bound field logbooks, sample labels, profile sheets, and field site sheets shall be completed prior to refilling the pit.

8. After items 1 through 7 have been completed to the satisfaction of the lead sampler, the site pit shall be refilled with the previously excavated materials. The earthen materials are to be replaced in the same order they were excavated with

topsoil placed on top of the filled pit. There will be some unavoidable mixing of the soil during the excavation.

9. Decontaminate all sampling equipment.

10. Move to the next site. If the previous site was the last site of the day, decontaminate the field sampling equipment, secure all equipment, and exit the site.

ATTACHMENT TO SOP SS-1
29 CFR 1926 SUBPART P - EXCAVATION, TRENCHING AND SHORING

STANDARD OPERATING PROCEDURE SS-3

SEDIMENT SAMPLING FROM STREAMS, PONDS, AND LAKES

STANDARD OPERATING PROCEDURE (SS-3)
SEDIMENT SAMPLING FROM STREAMS, PONDS, AND LAKES

SEDIMENT SAMPLING

Sediment sampling can consist of grab samples obtained from the top of the sediment layer or cores obtained by hand drilling or other means. Grab samplers collect only disturbed samples and should be used only after the sampling of the overlying water has been completed. A core sampler should be used when an undisturbed sample is required. Suggested techniques include the following:

1. In small, low flowing streams or near the shore of a pond or lake, a grab sample can be obtained by scraping up the sediments with a sample container. If an undisturbed sample is desired, a manually operated piston type core sampler can be used. The cylinder is pressed and/or hammered into the stream bed by hand and the piston retracts and holds the sample in the cylinder by means of a partial vacuum. The piston is also used to eject the sample.

2. To obtain sediments from larger streams or farther from the shore of a pond or lake, a Teflon beaker attached to a telescoping pole with a clamp may be used to dredge sediments. Cored sediment samples can be obtained by a spring loaded or piston driven core sampler suspended from a shore based mechanical arm and reel assembly.

   In most cases, a number of sediment samples should be collected along a cross-section of a river or stream in order to characterize the bed material adequately. A common practice is to sample at quarter points along the cross-section of the site selected. When the sampling technique or equipment requires that the samples be extruded or transferred at the site, they can be combined into a single composite sample. However, samples of dissimilar composition should not be combined, but should be stored for separate analysis.

3. To obtain grab samples of sediments from rivers or in deeper lakes and ponds, a spring loaded sediment dredge may be used by lowering the sampler to the appropriate depth with a rope or cable. This sampler has a spring loaded rotating bucket which is initially rotated back into the body of the sampler and latched in place. When the sampler contacts the sediment bed, the latch trips and the spring causes the bucket to rotate into the sediment in a 180^o arc. The cutting edge of the bucket is driven upwards against a seal to ensure that material will not be lost when the sampler is raised.

   Core samples can be obtained in deep water from water craft by either a gravity type sampler or a piston driven core sampler. The core barrel on a gravity sampler has a ball valve and steel cutting head at the base and lead weights at the top. The sampler is lowered into the water by cable off a power-operated reel, and is allowed to accelerate into the sediments in order to achieve penetration. If greater penetration is required, heavier and larger piston type core samplers can be utilized.

   When collecting sediment samples in lakes, ponds, and streams the site should be approximately at the center of the water mass. This is particularly true for reservoirs that are formed by the impoundment of rivers or streams. Generally, the coarser grained sediments are deposited near the headwaters of the reservoirs, and the bed sediments near the center of the water mass will be composed of fine-grained materials. The shape, inflow pattern, bathymetry, and circulation must all be considered when selecting sediment sampling sites in lakes or reservoirs. In rivers or streams, fine grained sediments are deposited on the outside of bends and downstream from islands or obstructions.

4. The optimum number of samples to be taken and composited to obtain a representative sample from each location is dependent on the nature and heterogeneity of the sediment, the variable(s) under study, and the volume of the samples obtained. This is site- and job-specific and is to be addressed in the site-specific SAP.

5. The sampling device should be decontaminated between locations.

STANDARD OPERATING PROCEDURE SS-4

FIELD LABORATORY DETERMINATION OF SOIL pH

Standard Operating Procedure
Field Laboratory Determination of Soil pH (SS 4)

MATERIALS REQUIRED

1. Orion pH meter [refer to Standard Operating Procedure (SOP) H-2 for calibration and operating procedures]
2. pH probes and pH-4, pH-7 and pH-10 buffer solutions
3. Hard plastic spoons (teaspoon size, two minimum)
4. Glass stirring rods (two minimum)
5. 50-milliliter (ml) sample beaker (or disposable cup) with lid. Quantity depends on number of samples.
6. Deionized/distilled (DI/DS) water (two liters minimum)
7. 0.01 M $CaCl_2$ (1.47 grams $CaCl_2$ x 2 H_2O/liter = 2 liters minimum)
8. Paper towels

FIELD LABORATORY PROCEDURES

1. Place approximately 1 teaspoon (about 10 grams) of soil sample in sample beaker.

2. Add about 20 ml of 0.01 M $CaCl_2$ into beaker.

3. Stir with glass rod to make slurry. (Clean glass rod with DI//DS water prior to preparing another soil sample.)

4. Attach lid to beaker and shake vigorously.

5. Let beaker stand until sediment has settled. (This will take about 5 minutes for sandy sample to 30 minutes for clayey samples.)

6. Calibrate pH meter according to procedures outlined in SOP H-2.

7. Immerse clean pH probe in the "clean" solution. Gently move the probe up and down without disturbing the sediment.

8. Record pH value of solution in field log book when stabilized.

9. Decontaminate pH probe and continue on to next sample.

Reference:

Manual on Soil Sampling and Methods of Analyses, 2nd edition, 1978, prepared by Subcommittee (of Canada Soil Survey Committee) on Method of Analysis, J.A. McKeague, Ed.

STANDARD OPERATING PROCEDURE SS-6

COMPOSITING SOIL SAMPLES

STANDARD OPERATING PROCEDURE SS-6
COMPOSITING SOIL SAMPLES

INTRODUCTION

Compositing methods will be used when it is desirable to obtain a single sample representing the mean or average characteristics of a soil interval. This technique is good for obtaining average soil contaminant values; however, it tends to mask or obscure variations within the soil column. This procedure applies to samples taken for inorganic analysis. Volatile or semi-volatile organic compounds are lost using these methods and thus shall not be sampled in this manner.

METHOD

The procedure applies primarily to split spoon sampling, but can be adapted to suit other sampling methods. After the spoon is withdrawn from the boring and opened, and the upper several inches of potentially disturbed material is removed and discarded, the sample shall be split lengthwise with a stainless steel knife. One-half of the sample is transferred to a large stainless steel mixing bowl or pan. The other lengthwise half is placed in a glass sample jar and retained as a sample split for that depth interval. This procedure is repeated until the desired number of discrete split spoon samples have been collected for the composite.

The material in the mixing bowl or pan is then broken up and mixed thoroughly with a stainless steel spoon or trowel. Careful observation of the soil will indicate when homogenization is complete. The soil is then spread evenly in the bottom of the bowl or pan. The soil mass is quartered, and an equal-volume subsample taken from each quarter. These subsamples are placed in the sample jar to be sent to the laboratory for analysis. The remainder of the homogenized soil composite is saved and archived as a split.

STANDARD OPERATING PROCEDURE SS-7

PREPARATION OF SOIL CORE SAMPLES FOR LABORATORY ANALYSIS

STANDARD OPERATING PROCEDURE SS-7
PREPARATION OF SOIL CORE SAMPLES FOR LABORATORY ANALYSIS

FIELD LABORATORY PROCEDURES

The procedures outlined below are for the preparation of core samples for analyses of inorganic chemicals.

Samples obtained for analyses of organic chemicals will be shipped directly to the laboratory in the sealed brass tube in which they were collected. No preparation is necessary.

1. Ensure samples are well-sealed with paraffin and store them in a cool area.

2. Prior to use, and between samples, wash all utensils with a detergent solution, followed by a tap water rinse, a dilute acid rinse, and a final rinse with distilled/de ionized water.

3. Spread clean plastic under the sample holder to catch any sample which may spill during cutting.

4. Place the length of core section selected for analysis in the core holder.

5. Using a stainless steel knife, cut the core sections lengthwise into two subsamples, using the top edges of the core holder as a guide.

6. Split the core lengthwise into two subsamples using a plastic spatula and stainless steel blades.

7. Photograph the subsamples of the core section

8. If the core section is not entirely filled with material, the contents of the core should be split in half as best as possible. Note in the bound field logbook any sections that were not filled, and describe how the material was divided. The mixing bowl and utensils should be stainless steel or plastic.

9. After mixing as well as possible, remove approximately 40 g of material from the core half that is to be sent to the laboratory. Use this 40 g of material for laboratory analyses of slurry pH, and percent moisture. Remove 8-ounces of materials from every tenth sample to perform duplicate slurry pH and percent moisture analyses.

10. Send remaining material in the half-core section to the laboratory in a 16-ounce wide-mouth jar, or if the sample is too large for the jar, place in a plastic zip-lock bag. To guard against leakage, be sure to double-bag all samples. The laboratory requires a minimum of 200 g (dry weight) of sample. The standard 16-ounce jar is sufficient size to contain 200 g sample of typical soil material.

NOTE: The sample analysis request form provides the sample numbers and quantity of sample to be sent by the laboratory to the EPA or the reference laboratory after drying and grinding. Note which sample numbers are to be composited after grinding for whole core analysis.

11. Wrap the remaining half of the core section with plastic wrap ensuring it is well-sealed with tape. Label and store in a cool secured area.